GREAT BOOKS OF THE WESTERN WORLD

ROBERT MAYNARD HUTCHINS *EDITOR IN CHIEF*

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DARWIN

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION

THE DESCENT OF MAN

AND SELECTION IN RELATION TO SEX

BY CHARLES DARWIN

WILLIAM BENTON *Publisher*

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GENERAL CONTENTS

served and unfavorable ones to be destroyed The result would be the formation of a new species Here then I had at last a theory by which to work

He confided this theory to Hool er and Lyell who urged him to write out his views for publication But Darwin worked deliberately he was only half through his projected book when in the summer of 18o8 he received an es ay from A R Wallace at Ternate in the Moluccas containing exactly the same theory as his own Darwin submitted his dilemma to Hooker and Lyell to whom he wrote Your words have come t i

u i evious year together with Wallace s essay the joint work being entitled *On the Tendency of Species to form Varieties and on the I erpetuation of Varieties and Species by Natural Means f Selection*

A year later on November 24 18o9 *The Origin of Species* appeared The entire first edition of 1 2 0 copies was sold on the day of publication A storm of controversy arose over the book reaching its height at a meeting of the British Association at Oxford where the celebrated duel between T H Huxley and Bishop Wilberforce ook place Darwin who could not sleep when he answered an antagonist har lly took Lyell s advice and saved both time and temper by avoiding the fray

In his work I owever he stayed close to l is the is He expanded the material of the first chapter of the *Origin* into a l l V

tion to Sex (1871) Darwin fulfilled his statement in the *Origin* that light would be thrown on the origin of man and his history The *Expression of the I motions* (187.) offered a natural explanation of phenomena which appeared to be a difficulty in the way of the acceptance of evolution His last works were concerned with the form movement, and fertili ation of plants

Darwin s exi tence at Down was peculiarly adapted to preserve his energy and give lirect order to his activity Because of his continual ill healt i his wife took pains to shiel l him from every avoidable annoyance He observed the same routine for nearly forty years, his days being carefully parcelled into intervals of exercise and light rea ling in such proportions that he could utilize to hi fullest capacity the four hours he levoted to work His scientific reading and experimentation as well were organized with tl e most ri orou economy Even the phases of his intellectual life non essential to his work bec ime as he put it atrophied a fact which he re rette l as a loss of happiness Such non scientif c reading as he di l was purely for relaxation an l he thought that a law ought to be passe l again t unhappy endin s to n t

wa

th. s son Franci marvelled that he co ll preserve it with such an undemonstrative race as we are When he died on April 19 1882 his family wanted him to be buried at Down pul c feeling decreed that he shoul l be interred in Westminster A bey where l e was laid beside Sir I aac Newton

GENERAL CONTENTS

CONTENTS THE ORIGIN OF SPECIES

But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws.

WHEWELL: *Bridgewater Treatise*.

The only distinct meaning of the word 'natural' is *stated*, *fixed*, or *settled*; since what is natural as much requires and presupposes an intelligent agent to render it so, i.e., to effect it continually or at stated times, as what is supernatural or miraculous does to effect it for once.

BUTLER: *Analogy of Revealed Religion*.

To conclude, therefore, let no man out of a weak conceit of sobriety, or

progress or proficience in both.

BACON: *Advancement of Learning*.

AN HISTORICAL SKETCH

OF THE PROGRESS OF OPINION ON THE ORIGIN OF SPECIES PREVIOUSLY TO THE PUBLICATION OF THE FIRST EDITION OF THIS WORK

I WILL here gi e a b ef sk tch f th p ogress of opinion on *Th Orig n f Spe es* Unt l re- t h rre t m j rity f nat ral ts be-

k hel ed that pec es und rgo modi a

mod fi ations was

as B ff n. B t as his pini ns flu t ted greatly t liff rent periods, l as he does n t ent on the ca ses r means f th transf r mation of peci s, I need n t h re e t r n details.

ing att nti n to the probab lity of all change in the ganic, as well as n the ino ganic world, being th res lt of law and n t f miracul us interpo t on. Lamarck seems to have been chi fl led to hi conclusi n n the gradual hange of pecies, by the difficulty f distin uishing peci and va ties, by the almost pe fect gradati n of f rms in certain gro ps, and by the anal of d mesti prod ctions W th respect to the means f n odificati L ttrib ted som thi g to th direct a ti n of th ph cal co d t ns f l f something to th cross f alr ady e t ng f ms, an l m ch t use a d dis se th t s, to th effects f hal t. T th latt ncy he seem to ttr but all tl e bea tif l daptati ns n n t re — h tl l g neck f tl e giraff f r

m nt and as

prog ss, n rde t ccou t f the xist nce t th prese t l of simple producti ns, he

q ently i 1815 in the Introd ct n to his *Hist nat d maux ns rt b es* In these orks he ph lds th doctrin that ll pec es, incl din man, ar desce ded from oth pe cies. H first did the min t se ce f arous-

L f wr tten t j l is son, pected, as ea ly as 1 9 that what call pecies re var us d gen rat ns f th sam type. It was n t u t l 1828 that h published his con t n that th ame f rms ha n t been perpetuated nce

1

not mad for th sak of this, b t t wa th esult of accide And l k manner t the th parts hich here ppears t ex st l pt t on to nd. Wherewe er therefore ll thi gs t the (hat is ll the part of ne hole) happe ed lik as if they ere m l for he sak of som th ng, th se tre preserved, ha g bee pproprt t ly consti- t ted by an ernal po t eity nd hatsoever things ere not h e nsti ted, perished, nd still per h. W here see the pri cipl of nat ral selec- shado ed forth, but how littl Ari totl f lly apprehended the principle sho by his remarks the formation of the eeth.

is gi of B ff co clu the sam subject. It curi how larg ly m grandf the D Er s- mus Darw n, ticipated th vi w d erro eo gro ds I p f Lamar k hi *Zoonom* (L pp. 500– 10) p blished 1 94 Accord g t I d re Geoffro th re is d bt that Goeth was trem partisa f sim lar ws, as sh w th I troduct t k ritte in 1 94 d 1 95 b t not p blished t ll lo g fterwards h has po tedly remarked (*Goethe al N t rforscher* to H Karl Meding s. 34) th t th f ture quest for tur alists ll be ho for tance cattle got their horns, d t f hat th y re used It is rathe ingular instance of th man wh ch similar vi w arise t about the sam tim that Goeth Germ y D Darw in E gland, nd Geoffroy Sai t Hilaire (as shall mmediat ly see) in France, cam t th sam conclusi th rigin of pecies, the years 1 94–5

the origin of all things Geoffroy seems to have relied chiefly on the conditions of life or the *monde ambiant* as the cause of change He was cautious in drawing conclusion and did not believe that existing species are now under going mo lification and as his son adds *C est donc un probleme a réserver entierement à l ave nir supposé meme que l avenir doive avoir prise sur lui*

In 1813 Dr W C Wells rea l l efore the Royal Society An Account of a White female part of whose skin resembles that of a Negro but his paper was not published until his fa mous *Two I ssays up n Dew and Single l isi n* appeared in 1818 In this paper he listinctly recogni es the principle of natural selection and this is the first recognition which has been *indicated but he applies it only to the races* of man and to certain characters alone After remarking tl at Negroes and mulattoes enjoy an immunity *from certain tropical diseases he* observes fir tly th it all animals ten l to vary in some degree an l secondly that agricul turists improve their d mesticate l animals by selection an l then he ad ls but what is done in this latter case l y art seems to be done with equal efficacy thou h more slowly by nature in the formation l varieties of man kind fitte l for the country which they in habit Of the accidental varieties of man which would occur among the first few and scattered inhabitants of the mi l lle regions of Africa some one would be l etter fitte l than the others to bear the li eases of the country This race would consequently multiply while the others would lecrease not only from their in al ility to sustain the attacks of disease but from their incapacity of conten ling with their more vigorous neighbors Il e colour of this vigorous race I take for granted from what has been already said would be dark But the same di position to form varieties still existin a darker and a darker race woul l in the co ir e of time occur and as the darkest woul l be the best fitted for the climate tl is woul l at length l ecome the mo t prevalent if not the only race in the particular country in which it ha l originated He then exten ls these sam v ers to the white inhabitants of col ler climates I am in lebted to Mr Rowley of the Un te l States for having called my attenti n tl r u h Mr Brace to the above pas age in Dr W ll work

The Hon an l Rev W Herbert afterwards Dean of Manche ter in tl e fourth volume of the *Horticultural Tran acti ns* 1822 an l in his work on the *Ama ,llidaceæ* (1837 pp 19 339) declares that horticultural experiments have established beyond the possil ility of refuta tion that botanical species are only a higher and more permanent class of varieties He exten ls the same view to a l

ed chiefly l y ation all our

In 18?6 Professor Grant in the conclu ling paragraph in hi well known paper (*I dinburgh I hil sophical Journal* v l

p ounsue l in the *Lancet* in 1834

In 1831 Mr l atrick Matthew published his work on *Naval Timber and l boriculture* in *which he gives precisely the same* view on the origin of species as that (pre ently to l e allud ed to) propoun le l by Mr Wallace and myself *in the Linnean Journal* an l as that enlarged in the present volume Unfortunately the view was given by Mr Matthew very briefly in scattered passages in an appendix to a work on a different ul ject s that it remained un noticed until Mr Matth w him elf drew at tention to it in the *Ga de e s Ch o icle* on April 7th 1860 The liff

L a y re populate l at succes ive perio l and then re stocke l an l e give a an alternative that new forms m y be generate l with ut the pre ence of any moul l or germ of former aggregates I a not sur that I un lerstan l some pa sages but it eem that he attributes much influence to the li ect a tion of the con litions of life He cl arly sa s however the full force of tl e princ l le of

ies (1836 p 147) cl rly expre s his l elief tl at varieti s slowly l e o ne changed into permanent sp cie h h are no longer capable of inter r sin

Rafinesque in l is *New Fl a of No th Amer ica* publi l ed in 1836 r t (p 6) a follo s — All p ci s migl t l ave l e a arieties once an l many varieties are gra lually l ecoming speci s l y a uming c n tant an l peculiar character l ut furtl er on (p 18) he ad ls except the origin l types or ancestors of tl e genus

In 1843-44 Pr f ssor H ld man (*Boston Journal f Nat Hist U States* ol 468) has ably g en th argum nts f r and g st th hypothesis f th d l pm nt and modi ficatio of species h seem to l an towards the d of chang

The *l est g s f C tion* appeared in 1844 In the tenth and m h mpr ed ed t n (18.3) the an ym tl sa (p 1 5) — Th pos t d t rm ed n aft r much consideratio ts, th t tl l f an mated be gs, from tl simpl t a d ld st up t the h ghest and most rece t, a e nd r the pro dence of God, the lts, *fi st* f an m p be hich has been imparted t th fo m f lif ad ancing th m d fin t tim s, by g n tion, through grad of ganisat n t m mati g t th h ghest d coty led ns and v te b ta, these grade being f w n mbe and rally marked by int rv ls f l ar act h ch fi d to be p t cal d fficulty ascertain g ffi t es *nd* f th r imp be co ected w th th t l fo ce t n l g, tl co se f g t to mod fy gan c tructures cco d ce w th t rn l cum mst ces, a food th t re f tl hab-

progresses by dd l ps, b t th t tl ffects p od ced by th co d t ns f l f are grad al. H argues w th m h f ce g ral gr nds

woodpeck ha becom adapted t ts pec liar hal ts f lif Th w k, from ts pow rf l d brilliant t l th gh d pl g tl arh editions littl accu t kn ledg and great want of sci t f ca t mmediat ly had a ry id circulat l m p t has d celle t scrv ce tl co try call g tt t tl l ject m g prej dice d th preparing tl gro d f th reception f nalo s.

I 1846 the t an geol gist M J d Omalius d H ll p l lisl ed an cell t tl h hort pape (*B llet n d l'acad y d l de* tom p 81) l p that t more p obabl that w pec ha bee p l ced t y desce t tl mod f cat tl n that they ha bee m ratel cr ted tl e author first p om lg ted tl 1831

P f sor Ow n m 1849 (*Natu e of Limbs* p 86) w ote as f llows — Th arch typal d a was manif ted m the fl sh und r di rse uch mod ficat ons, upon this planet, long p tol th e tenc of th s an mal species tl at act ally ex mplify t. To what n t ll s act ally ex mplify t. To what n t ll s r secondary uses the o d rl ucess n and pr g l p pl n m n may ha e In l

l sme l —

c nfid n e n th co l s n tnat th t yx of N w Z l nd and tl red grouse of England w r d t et cr l ns n and fo th se lands r pe t ely tl ay ls t m y b w ll t b ar m mind that by th w d cre ation th zoolog t means process h kn n t wh t. He mplifi s thus idea by adding that wh n ch ca as tl t of th red g use are e um ted by tl oologi t as d ce f dust ct ti n f the b l and f r ch l ls, h l fly p esses tl t he kno s n t h w the red g came to be tl e and th re lu. ly gn fy g lso by th mode of xp ss g s h gn rance his b lief th t both tl l d and tl land owed tl r g n t gr t fi t C eati e C If w mt p et th se se t nce n n the sam address, e by th th r t pp a th t thi m nt phi losoph r f lt 1858 h confid ce sh k n that th Apt ryx a d tl red gr use fi t ppear d m tl ir p ecti l m h kn w n t l w o b som p ocess h kn w n t what.

Th add ss was d l d ft r th p pe s by Mr Wallace d myself n the O gin of Spec s, p esentl t be f rred t had been

by ch xp es ns as th continu us pt t f cre t po that I n l ded P o-fesso Ow w th th r p lmo t l g ts a b ing firmly co nced of the mm tab l ty f pecies b t t appears (*Anat f V t b at s* l p 96) that tl was n my part a p c-post ro rro In th last edit l thi k I inf rred and th inf ce till c ms to m perfectly p t, from passa b nn g w th th ds n d bt th typ f m &c. (*bid* l p xxx) that I rof sor O adm tt d that nat l l ct n may ha d n some-thi g th f rm t f a n w pec b t

thus it appears (*ibid* vol iii p 798) is inaccurate and without evidence I also gave some extracts from a correspondence between Professor Owen and the Editor of the *London Review* from which it appeared manifest to the Editor as well as to myself that Professor Owen claimed to have promulgated the theory of natural selection before I had done so and I expressed my surprise and satisfaction at this announcement but as far as it is possible to understand certain recently published passages (*ibid* vol iii p 798) I have either partially or wholly again fallen into error It is consolatory to me that others find Professor Owen s controversial writings as difficult to understand and to reconcile with each other as I do As far as the mere enunciation of the principle of natural selection is concerned it is quite immaterial whether or not Professor Owen preceded me for both of us as shown in this historical sketch were long ago preceded by Dr Wells and Mr Matthew

M Isidore Geoffroy Saint Hilaire in his lectures delivered in 18.0 (of which a resume appeared in the *Revue et Mag de ology* Jan 1851) briefly gives his reason for believing that specific characters *sont fixés pour chaque espece tant qu elle se perpétue au milieu des memes circonstances ils se modifient si les circonstances ambiantes viennent à changer En résumé* l observation *des animaux sauvages démontre déja la variabilité limitée des especes Les* experiences *sur les animaux sauvages devenus domestiques et sur les animaux domestiques redevenus sauvages la démontrent plus clairement encore Ces m mes expériences prouvent de plus que les differences produites peuvent etre de* valeur generique In his *Hist nat generale* (tom ii p 430 18 0) he amplifies analogous conclusions

From a circular lately issued it appear that Dr Freke in 18.1 (*Dublin Medical Press* p 3??) propounded the doctrine that all organic beings have descended from one primordial form His grounds of belief and treatment of the subject are wholly different from mine but as Dr Freke has now (1861) published his essay

Mr Herbert Spencer in an essay (originally

opment of organic beings with remarkable skill and force He argues from the analogy of domestic productions from the changes which the embryos of many species undergo from the difficulty of distinguishing specie and varieties and from the principle of general gradation that species have been modified and he attributes the modification to the change of circumstances The author (185) has also treated Psychology on the principle of the necessary acquirement of each mental power and capacity by gradation

In 18.2 M Naudin a distinguished botanist expressly stated in an admirable paper on the Origin of Species (*Revue horticole* p 102 since partly republished in the *Nouvelles Archives du muséum* tom i p 171) his belief that species are formed in an analogous manner as varieties are under cultivation and the latter process he attributes to man s power of selection But he does not show how selection acts under nature He believes like Dean Herbert that species when nascent were more plastic than at present He lays weight on what he calls the principle of finality *puissance mystérieuse indéterminée fatalité pour les uns pour les autres volonte providentielle dont l action incessante sur les êtres vivants détermine à toutes les époques de l existence du monde la forme le volume et la durée de chacun d eux en raison de sa destinée dans l ordre de choses dont il fait partie C est cette puissance qui harmonise chaque membre à l ensemble en l appropriant à la fonction qu il doit remplir dans l organisme général de la nature fonction qui est pour lui sa raison d etre* [1]

In 18 3 a celebrated geologist Count Keyserling (*Bulletin de la soc géolog* 2nd ser tom x p 3 7) suggested that as new diseases supposed to have been caused by some miasma have arisen and spread over the world at certain periods the germs of existing species may have been chemically affected by circumambient molecules of a particular

nature, and thus have gi n rise to n w f rms.

In this same year 1853 Dr Schaaffhausen published an excell t pamphl t (I e I nd de Nat h st I ereins der P eu Rhe lande &c.) n h h he maintains th d l pm t of o ganic forms the arth H inf rs that many species ha kept tru f l g periods, where as a f w ha become modified. Th distin tion of species he xplains by th destructi n of intermediate grad ted forms. Th s h ing plants and animals are t separ ted from th extinct by n w cre ti ns, but are to be gard ed as th ir desce dants thr gh continued re prod cti n.

A well kno n Fre ch botanist, M. Lecoq, writes in 1854 (*Et des e ge g ph. bot t m i., p. 250*) *O roit q nos echer hes la fixit la variat n de l' pece, no is condi ent directement ux idées émises par deux hommes justement célèb e G off y S nt H la r t Goethe"* Som the passages scatte ed through M. Lecoq larg w k, mak t a little d bif l h w far he tends his w on the modificati n f pecies.

The Philosophy f C ti n h been tre ted in mast ly mann r by th R v Bad P ll, n hi E y o the U ty f Worlds 1855 N thing can be m re triking than th mann n wh ch he h ws th t the introd cti n f n w pecs is regular n t a casual phen menon as Sir J hn H schel expresses t, n nat al n cont adistin tion to a miracul process

Th third l m f the J nal f th Lin nean Soc ty co tains p pers, ead July 1 t 1858, by Mr W llace and my lf in which as stated in th introd ctory remarks t th is ol ume, the theory f N t ral Selecti is pro m lg ted by M Wall ce w th adm rable force and clearn ss.

Von Bae toward h m II ool g ts feel so prof und a respect, expressed about the year 18 9 (see Prof Rud lph Wagne *Zoologis I Intl polog sche Untersuchungen*, 1861

I) h con cti n chiefly grounded on the laws f geo raph cal distr but n that forms n w perfe tly distinct ha e descended from a i l p rent f rm

In June, 1859 Profe or Huxley gave a lec ture bef re the R yal In tituti n n the I er sist nt Types f Animal Life R ferring to such cases, h remarks, It is difficult to com preh nd the meani g of uch facts as the e if w s ppo e that ach peci s f anim l and plant, or ach great type f organ sation, was f med a d placed pon tl e su face of the

d t n o re clati n as t s opposed to th g n ral analogy of natu e If on th oth r hand we v w Pers t nt Types in relati n t that hypothesis which s pposes th specie l v g t any tim to be th esult of th grad

nl ne t h ch physiol gy l ds any coun

In Decembe 1859 D Hooker publ l ed h *Int oduct n t th Au t l n Flo* In th first part of this great w k he adm ts the truth of th d scent and mod ficat n f pe ci s, d upports th doctrine by ma y r g nal l rvati ns

The first editi n f th w k as published n N mbe 24th 1859 nd tl second edi ti n J nuary th 1860

When on board H M S *Beagle* as naturalist I was much struck with certain facts in the distribution of the organic beings inhabiting South America and in the geological relations of the present to the past inhabitants of that continent These facts as will be seen in the latter chapters of this volume seemed to throw some light on the origin of species—that mystery of mysteries as it has been called by one of our greatest philosophers On my return home it occurred to me in 1837 that something might perhaps be made out on this question by patiently accumulating and reflecting on all sorts of facts which could possibly have any bearing on it After five years work I allowed myself to speculate on the subject and drew up some short notes these I enlarged in 1844 into a sketch of the conclusions which then seemed to me probable from that period to the present day I have steadily pursued the same object I hope that I may be excused for entering on these personal details as I give them to show that I have not been hasty in coming to a decision

My work is now (1859) nearly finished but as it will take me many more years to complete it and as my health is far from strong I have been urged to publish this abstract I have more especially been induced to do this as Mr Wallace who is now studying the natural history of the Malay Archipelago has arrived at almost exactly the same general conclusions that I have on the origin of species In 1858 he sent me a memoir on this subject with a request that I would forward it to Sir Charles Lyell who sent it to the Linnean Society and it is published in the third volume of the *Journal* of that society Sir C Lyell and Dr Hooker who both knew of my work—the latter having read my sketch of 1844—honoured me by thinking it advisable to publish with Mr Wallace s excellent memoir some brief extracts from my manuscripts

This abstract which I now publish must necessarily be imperfect I cannot here give references and authorities for my several statements and I must trust to the reader reposing some confidence in my accuracy No doubt errors will have crept in though I hope I have always been cautious in trusting to good authorities alone I can here give only the general conclusions at which I h e arrived with a few facts in illustration but which I hope in most cases will suffice No one can feel more sensible than I do of the necessity of hereafter publishing in detail all the facts with reference on which my conclusions have been grounded and I hope in a future work to do this For I am well aware that scarcely a single point is discussed in this volume on which facts cannot be adduced often apparently leading to conclusions directly opposite to those at which I have arrived A fair result can be obtained only by fully stating and balancing the facts and arguments on both sides of each question and this is here impossible

I much regret that want of space prevents my having the satisfaction of acknowledging the generous assistance which I have received from very many naturalists some of them personally unknown to me I cannot however let this opportunity pass without expressing my deep obligations to Dr Hooker who for the last fifteen years has aided me in every possible way by his large stores of knowledge and his excellent judgment

In considering the Origin of Species it is quite conceivable that a naturalist reflecting on the mutual affinities of organic beings on their embryological relations their geographical distribution geological succession and other such facts might come to the conclusion that species had not been independently created but had descended like varieties from other species Nevertheless such a conclusion

fied so as to acquire that perfection of structure and coadaptation which justly excites our admiration Naturalists continually refer to external conditions such as climate food &c as the only possible cause of variation In one limited sense as we shall hereafter see this may be true but it is preposterous to attribute to mere external conditions the structure for instance of the woodpecker with its feet tail beak and tongue so admirably adapted to catch insects under the bark of tree In the case of the mistletoe which draws its nourishment from certain trees which has seeds that must be transported by certain birds and which has flowers with separate sexes absolutely requiring the agency of certain insects to

bring pollen from one flower to the other, it is equally preposterous to account for the structure of this parasite, with its relations to several distinct organic beings, by the effects of external conditions, or of habit, or of the volition of the plant itself.

It is, therefore, of the highest importance to gain a clear insight into the means of modification and coadaptation. At the commencement of my observations it seemed to me probable that a careful study of domesticated animals and of cultivated plants would offer the best chance of making out this obscure problem. Nor have I been disappointed; in this and in all other perplexing cases I have invariably found that our knowledge, imperfect though it be, of variation under domestication, afforded the best and safest clue. I may venture to express my conviction of the high value of such studies, although they have been very commonly neglected by naturalists.

From these considerations, I shall devote the first chapter of this Abstract to Variation under

portant, we shall see how great is the power of man in accumulating by his Selection successive slight variations. I will then pass on to the variability of species in a state of nature; but I shall, unfortunately, be compelled to treat this subject far too briefly, as it can be treated properly only by giving long catalogues of facts. We shall, however, be enabled to discuss what circumstances are most favourable to variation. In the next chapter the Struggle for Existence amongst all organic beings throughout the world, which inevitably follows from the high geometrical ratio of their increase, will be considered. This is the doctrine of Malthus, applied to the whole animal and vegetable kingdoms. As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally *selected*. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.

This fundamental subject of Natural Selection will be treated at some length in the fourth chapter; and we shall then see how Natural Selection almost inevitably causes much

Extinction of the less improved forms of life, and leads to what I have called Divergence of Character. In the next chapter I shall discuss the complex and little known laws of variation

a simple organ can be changed and perfected into a highly developed being or into an elaborately constructed organ; secondly the sub-

considered the geological succession of organic beings throughout time; in the twelfth and thirteenth, their geographical distribution throughout space; in the fourteenth, their classification or mutual affinities, both when mature

No one ought to feel surprise at much remaining as yet unexplained in regard to the origin of species and varieties, if he make due allowance for our profound ignorance in regard to the mutual relations of the many beings which live around us. Who can explain why one species ranges widely and is very numerous, and why another allied species has a narrow range and is rare? Yet these relations are of the highest importance, for they determine the present welfare and, as I believe, the future success and modification of every inhabitant of this world. Still less do we know of the mutual relations of the innumerable inhabitants of the world during the many past geological epochs in its history. Although much remains obscure, and will long remain obscure, I can entertain no doubt, after the most deliberate study and dispassionate judgment of which I am capable, that the view which most naturalists until recently entertained, and which I formerly entertained—namely, that each species has been independently created—is erroneous. I am fully convinced that species are not immutable; but that those belonging to what are called the same genera are lineal descendants of some other and generally extinct species, in the same manner as the acknowledged varieties of any one species are the descendants of that species. Furthermore, I am convinced that Natural Selection has been the most important, but not the exclusive, means of modification.

CHAPTER I

VARIATION UNDER DOMESTICATION

Causes of Variability

When we compare the indi fuals of th same ariety or   b an t of ur old r cult ated plants and animals, on of the first points hich trikes u   s that th   gen rally d   more from ach oth r than do the indi viduals of any one species or ariety in   tate of nature. And if e reflect on the a t d ver it of the plants and animals which ha e been cult ated, and   hich ha e   aried during all   es und   the   ost diff rent   limates an l tre tment, w   are dri   n to con l u   that this great ariab lit   d   to our domest   productions ha ing been raised un l   er d t ons of lif   t so uniform as, and som what diff   t from, those t   wi l th parent pec es had bee   posed und   ature There is, also, some probabilit   in th   w propou ded l y Andrew K ght, that tl   ariability m y be partl connected w th   ces of food. It seems lear that rganic bein   mu t be   posed dur ing se   ral ge   rations t   n w condit ons to cause an   gre t amount of   ariation and that, the the organ sat on has once begu   t   arr t g   all co tin   arvin for man gen rations. N case   on record of   ariabl or ganism ceasin t   ary und   cult   t on. O oldest cult   ted plants,   l   wh t   t ll yield new   n t s   ldest d om t cated ani mals re t ll   pal l of rap d impro   t or   od ication

  As far as I am ble t judge aft   long t tention t the   ject th cond t ons of lif   ppear t   act in tw   s,—d rectl   on th bo e organisat on or on ce t in part   lo d ind rectl   b   affecting th reprod ti t m With re pect t   the lirect act on w m t l ar   n d that in   ry case as Pro fessor Weismann has lat l insi ted,   d as I ha   incidentall sl   in work on Vari tio   nder Domest cation, th re are two f ctors namel   the nature of th   organism, and th nature of the condit ons. Th forme seems t be much the more important for nearl sim ilar ariations som times arise nde   as far as   can judge d ssimilar cond tions and, n the the hand, dissim lar   ariat ons arise u de cond tions which   ppear t   be   arly uni form. Th   ffects on the off pring are eithe d finite or ind finit   They m y be considered as l fin t   wh n all or nearly all the off pring of ndi d   ls exposed to certain cond t ons duri g   ral g   rations are mod fied in the sam m

t an

changes w   n us

d ced. Th re can h w   er be little d ubt abo t many slight changes,—such as size from the amount of food c our from the nature of the food, thickness of the   k n and hair from climat   &c. Ea h of the   ndless   ariat ons whi h we see in th plumage of our f wls mu t ha   had some   fficient ca se and if the sam c   n re t   ct uniforml d rin   long

nary

the insert on of   minute dro p of poison b   a gall-prod cing insect   how us what si gular m d ficat ons m ght result in th case of plants from a hemical hang in the nat re of th sap.

  I d fi t   ariabi ty is a much more com mon result of changed cond t on than definite ariab lit   nd has probabl   pla ed a more   t   rt t part in th form tion of ou domes-

casionall   ppe   n th   ou g of th same l tt   and in seed ngs from th sam seed-cap   l   At long   t rvals of t m   out of m ll ons f n d d   ls re red in th same ountry and fed o   arl   the sam food, d   iat ns of tru ture so trongly pronounced as to d serve to be called monstrosit es arise but mon tros t   cann t be separated b   any disti t l ne from slight   ariations. All su h changes of

indefinite   ffect   of th   cond tions of lif   on eac indi d al organ sm, in nearl   th same mann   as th   hill affects diff rent m n in an d finite mann   ccording to th ir stat   of bod   or constitut on, causing coughs or colds,

lich has ot in som country droop g ars true and tl w wl l has been gg ted that eti s tl e droop g d to dis se f tl e m sel f tl ar from tl e ls be kl m m ch alarmed, seems p b l le

Many la gul t r t some few f lich can be dinl een d w ll h aft r be briefly d scussed I w ll l l ll d to l t m y be called co lated ariat n Im

m

mm l l n l g t d h ad Som

(*Lachnanth*) wl ch eol ed tl bo p k anl h ch ca sed tl hoof f ll b t tl bl k ant es t drop ff and f th kers (Virg a sq tt) l led we lect tl l lack m mbers f l lt f g as tl y k ha a good l ce f l g ll l ss dog h mperf t teetl l g ha d and coarse ha red m is pt t l as asserted l g l m p geo w th f ll n l feet ha k l t e tl te t p ges w tl l tl k l ll feet, and tl se th l g l ks l g fect ll ce f man g sel t g l tl gm t g peculiar ty l ll l t ce ta l mod fy t t nall tl part f tl tru t re owing to tl m t law f corre- lat n.

Tl rs lts f th s, k n l t l ly l rstood la f ar t fi t ly co ple d d sifed It w ll w rtl l le caref lly t t l tl se ral tre t es n som of ou ld cult ted plants, as ll h ac th, potato, tl d ll a, & and t is really urprisi g t t th dless points of

important f u But tl n mber and div r h t ll d t ns f tru t both

f ll t nd tl best n tl s subje t No b eeu r d bt how tr ng is th t ndc y to nh r tan e th thk p od ce like h s fundam ntal bel f d bts ha e been thro n on thi prin l nly by theoret cal writ s Wh n any

l g

ppe n th pare t—say nce m g t se ral m ll on ind vid ls—and it ppears n th h ld th m re doctr n of chan almost comp l u to att b t ts re pp a n e to inh ta ce E ry m t h h d of case f all n m p ckly k n ha r bod s, & pp ing al m mb f tl sam f m ly If t ang and ar d iat ons f true t e ar e lly ah ted l ss trange and com m d iat n y be f eely dmitted to be h tabl I l p the correct way f w g tl wh l bject wo ld b t look at ll nl ta ce f y h ct wh t as ll rul nd n n l tance as th an mal

Th l w g rn g he tan f r the m t p rt u k w N can say why the sam pec liar ty l ffe nt d nd ls f tl e sam pec s, d ff t peci s is s me- ti inh t d and som t t so why the ch ld lt n r ert ce tain char t rs to ts grandf the g andm tl r r m m te ance to w l y a pecul ar ty is oft n t ns m tted from sex t both e es, to v l m comm ly b t n t lu ly to tl l k se It f t f som mpo ta to s, tl t peculia t e appear m tl e m l s f d mest b eeds r ft n transm tted ll l ly n a much gre t r d g ee to tl m l l n l m l n important rul wh l I tl k m be tru ted, is that, t what pe od f lif peculiarity fir t ap- pe s, t t ds t ppear tl ff pring t a corr po ding g th gh som times earli r

rheumatism or inflammation of various organs

With respect to what I have called the indirect action of changed conditions namely through the reproductive system of being affected we may infer that variability is thus induced partly from the fact of this system being extremely sensitive to any change in the conditions and partl f o

... uct species and that which may be observed with plants and animals when reared under new or unnatural conditions Many facts clearly show how eminently s

... an to tame an animal and few things more difficult than to get it to breed freely under confinement even when the male and female unite How many animals there are which will not breed though kept in an almost free state in their native country! This is generally but erroneously attributed to vitiated instincts Many cultivated plants display the utmost vigour and yet rarely or never seed! In some few cases it has been discovered that a very trifling change such as a little more or less water at some particular period of growth will determine whether or not a plant will produce seeds I cannot here give the

... mals under confinement I may mention that carnivorous animals even from the tropics breed in this country pretty freely under confinement with the exception of the plantigrades or bear family which seldom produce young whereas carnivorous birds with the rarest exceptions hardly ever lay fertile eggs Many exotic plants have pollen utterly worthless in the same condition as in the most sterile hybrids When on the one hand we see domesticated animals and plants though often weak and sickly breeding freely under confinement and when on the other hand we see individuals though taken young from a state of nature perfectly tamed long lived and healthy (of which I could give numerous instances) yet having their reproductive system so seriously affected by unperceived causes as to fail to act we need not be surprised at this system when it does act under confinement acting irregularly and producing offspring somewhat unlike their parents I may add that as some organisms breed freely under the mo unnatural conditions (for instance rabbits and ferrets kept in hutches) showing that their reproductive organs are not easily affected so will some animals and plants withstand domestication or cultivation and vary very slightly —perhaps hardly more than in a state of nature

... d that all of sexual ... is certainly an error For I have given in another work a long list of sporting plants as they are called by gardeners —that is of plants which have suddenly produced a single bud with a new and sometimes widely different character from that of the other buds on the same plant These bud variations as they may be named can be propagated by grafts offsets &c and sometimes by seed They occur rarely under nature but are far from rare under cult

... as been known suddenly to assume a new character and as buds on distinct trees growing under different conditions have sometimes yielded nearly the same variety —for instance buds on peach trees producing nectarines and buds on common roses producing moss roses—we clearly see that the nature of the conditions is of subordinate importance in comparison with the nature of the organism in determining each particular form of variation —perhaps of not more importance than the nature of the spark by which a mass of combustible matter is ignited has in determining the nature of the flames

Effects of Habit and of the Use or Disuse of Parts Correlated Variation Inheritance

Changed habits produce an inherited effect as in the period of the flowering of plants when transported from one climate to another With animals the increased use or disuse of parts has had a more marked influence thus I find in the domestic duck that the bones of the wing weigh less and the bones of the leg more in proportion to the whole skeleton than do the same bones in the wild duck and

... the udders in cows and goats in countries where they are habitually milked in comparison with the organs in other countries is probably another instance of the effects of use Not one of our domestic animals can be named

determining what charac ers are f g n ric va ue all such valuations bein t present m jural. When t is xplained how gen ra orig nate under nature t will be seen that w ha no right t expect oft n t find a gen ric amount of di rence in our d mesticated races.

In attempting to estimate th amount of structural difference between all ed d mesti races, we are soon in ol ed in doubt, from not knowing whethe they are descended from one or se eral pare t species. Thi point if t could be leared p, would be int rest f for in stance it could be sho n that th gre hound, bloodhound, t rrie spaniel, and l ll-dog ach ad know propaga th ir kind trul re the o pr of an single species, th n such facts would ha great w ht in making us doubt about th mm tal ut of th many closely allied nat ral pecies—f instance of the ma f es—inhal ting diff re t quarters of the orld. I d ot l h as w shall presently see that th whol amount f diff rence bet ee the se ral breeds of th d has been produced und domestication I beli that mall part of the difference is d to their being descended from distinct pecies. In the case of strongl marked races of som othe domesticated species, there is presumptive e en strong idence that all are descended from sin le w ld tock

It has oft bee assumed that man has chosen for domestication animals and plant having an extraordinary inhere t ten len to vary and lik wise t w th tand l rse climates. I do not d put that these capacities ha added lar l t the a of most of our domesticated productions b t how could a sa possibl know when h first tamed an animal, wether t ould ary in succeeding generations, and whethe t would ndure oth climates Has the litt arial lity of th ass and goose or the mall po of ndurance of armth by the reindee of cold b the common camel, pre ented their domestication I cannot doubt that if the animals and plants, equal in mber t ou domesticated prod c tions, and belongin t equall di rse classes and countries, re t n from a tat of nature and ould be made to breed for an e al number of generations unde d mestica tion, they would on an erag ary as largely as the parent species of ou xi tin domesticated productions ha aried.

In the case of most of our ancientl domesticated animals and plants, t is not possible to come to any definite conclusion, whethe th y are descended from one or several w ld species. Th argument mainly relied on by those who beli n th multipl origin of o r domestic animals is, that we find in the most ancient times, on th m numents f Egypt, and in the lake-habitations of Switze land, much di e sity n the breeds and that som of these an c l sely resembl or are e n iden tic th. t c to been supposed.

Sw tzerland cult ted se eral k nds f wheat and barle th pea, th e poppy for o l, and flax and they possessed se ral d mest cated animals. Th also carried on comm rce with othe nat ns. All this learl hows, as Hee has remarked, that th y had t this arly ag progressed con d rabl in civilisat on and this again mplies a long continued pre ous period of less d anced civil sati n, during whi h th domesticated animals, kept l dif f rent tribes in diff rent di tricts, might ha e varied and g n rise t distinct races. Since th disco rs of flint tools in th perficial formations f many parts of the world all geolo t beli that barbarian man xisted at an n rmously remote period an l w know that t th present day th re is hardl a tribe so barbarous, as n t to ha d mest cated t l a t th d g.

Th origin of mo t of ou domesti animals will probabl for remain v gue B t I may l re tat that, looking to th domest d s of th whole world, I ha aft r a labori us collect on of all known facts, come t the con cl that sev ral wild species of Can dae ha been tamed, and that their blood in some cases mingled togeth flows in the ins f ou domesti breeds. In regard t sheep and goat I can form n decided opinion. F om facts commun cated to me b Mr Blyth, on the habits, voice con tituti n, and truct re of the humped Indian cattle t is almost certain that th are descended from a diff re t b original stock from our European cattle and som competent judges beli that these latt ha had two or three wild prog nitors, —wheth or n t these deser to be called species. Thi con lusion, as w ll as that of the pecific distinction between th h mped and common cattle, may indeed, be looked pon as established by th admirable researches of Professor Rutim y r W th respect to horses, from reasons which I cannot h re g I am

In many cases this could not be otherwise thus the inherited peculiarities in the horns of cattle could appear only in the offspring when nearly mature peculiarities in the silkworm are known to appear at the corresponding caterpillar or cocoon stage But hereditary diseases and some other facts make me believe that the rule has a wider extension and that,

I

est importance in explaining the laws of embryology These remarks are of course confined to the first *appearance* of the peculiarity and not to the primary cause which may have acted on the ovules or on the male element in nearly the same manner as the increased length of the horns in the offspring from a short-horned cow by a long horned bull though appearing late in life is clearly due to the male element

Having alluded to the subject of reversion I may here refer to a statement often made by naturalists—namely that our domestic varieties when run wild gradually but invariably revert in character to their aboriginal stocks Hence it has been argued that no deductions can be drawn from domestic races to species in a state of nature I have in vain endeavoured to discover on what decisive facts the above statement has so often and so boldly been made There would be great difficulty in proving its truth we may safely conclude that very many of the most strongly marked domestic varieties could not possibly live in a wild state In many cases we do not know what the aboriginal stock was and so could not tell whether or not nearly perfect reversion had ensued It would be necessary in order to prevent the effects of intercrossing that only a single variety should have been turned loose in its new home Nevertheless as our varieties certainly do occasionally revert in some of their characters to ancestral forms it seems to me not improbable that if we could succeed in naturalising or were to cultivate during many generations the several races for instance of the cabbage in very poor soil (in which case however some effect would have to be attributed to the *definite* action of the poor soil) that they would to a large extent or even wholly revert to the wild aboriginal stock Whether or not the experiment would succeed is not of great importance for our line of argument for by the experiment itself the conditions of life are changed If it could be shown that our domestic varieties manifested a strong tendency to reversion —that is to lose their acquired characters whilst kept under the same conditions and whilst kept in a considerable body so that free intercrossing might check by blending together any slight deviations in their structure in such case I grant that we could deduce nothing from domestic varieties in regard to species But there is not a shadow of evidence in favour of this view to assert that we could not breed our cart and race-horses long and short horned cattle and poultry of various breeds and esculent vegetables, for an unlimited number of generations would be opposed to all experience

Character of Domestic Varieties difficulty of distinguishing between Varieties and Species origin of Domestic Varieties from one or more Species

When we look to the hereditary varieties or races of our domestic animals and plants and compare them with closely allied species we generally perceive in each domestic race as already remarked less uniformity of character than in true species Domestic races often have a somewhat monstrous character by which I mean that although differing from each other and from other species of the same genus in several trifling respects they often differ in an extreme degree in some one part, both when compared one with another and more especially when compared with the species under nature to which they are nearest allied With these exceptions (and with that of the perfect fertility of varieties when crossed —a subject hereafter to be discussed) domestic races of the same species differ from each other in the same manner as do the closely allied species of the same genus in a state of nature but the differences in most cases are less in degree This must be admitted as true for the domestic races of many animals and plants have been ranked by some competent judges as the descendants of aboriginally distinct species and by other competent judges as mere varieties If any well marked distinction existed between a domestic race and a species this source of doubt would not so perpetually recur It has often been stated that domestic races do not differ from each other in character of generic value It can be shown that this statement is not correct but naturalists differ much

beak, with a line of reversed feathers down the breast; and it has the habit of continually expanding slightly the upper part of the oesophagus. The Jacobin has the feathers so much reversed along the back of the neck that they form a hood; and it has, proportionally to its size, elongated wing and tail feathers. The trumpeter and laugher, as their names express, utter a very different coo from the other breeds. The fantail has thirty or even forty tail-feathers, instead of twelve or fourteen—the normal number in all the members of the great pigeon family: these feathers are kept expanded, and are carried so erect, that in good birds the head and tail touch: the oil-gland is quite aborted. Several other less distinct breeds might be specified.

In the skeletons of the several breeds, the development of the bones of the face in length and breadth and curvature differs enormously. The shape, as well as the breadth and length of the ramus of the lower jaw, varies in a highly remarkable manner. The caudal and sacral vertebrae vary in number; as does the number of the ribs, together with their relative breadth and the presence of processes. The size and shape of the apertures in the sternum are highly variable; so is the degree of divergence and relative size of the two arms of the furcula. The proportional width of the gape of mouth, the proportional length of the eyelids, of the orifice of the nostrils, of the tongue (not always in strict correlation with the length of beak), the size of the crop and of the upper part of the oesophagus; the development and abortion of the oil-gland; the number of the primary wing and caudal feathers; the relative length of the wing and tail to each other and to the body; the relative length of the leg and foot; the number of scutellae on the toes, the development of skin between the toes, are all points of structure which are variable. The period at which the perfect plumage is acquired varies, as does the state of the down with which the nestling birds are clothed when hatched. The shape and size of the eggs vary. The manner of flight, and in some breeds the voice and disposition, differ remarkably. Lastly, in certain breeds, the males and females have come to

lish carrier, the short-faced tumbler, the runt, the barb, pouter, and fantail in the same genus; more especially as in each of these breeds several truly-inherited sub-breeds, or species, as he would call them, could be shown him.

Great as are the differences between the breeds of the pigeon, I am fully convinced that the common opinion of naturalists is correct, namely, that all are descended from the rock-pigeon (*Columba livia*), including under this term several geographical races or sub-species, which differ from each other in the most trifling respects. As several of the reasons which have led me to this belief are in some degree applicable in other cases, I will here briefly give them. If the several breeds are not varieties, and have not proceeded from the rock-pigeon, they must have descended from at least seven or eight aboriginal stocks; for it is impossible to make the present domestic breeds by the crossing of any lesser number: how, for instance, could a pouter be produced by crossing two breeds unless one of the parent-stocks possessed the characteristic enormous crop? The supposed aboriginal stocks must all have been rock-pigeons, that is, they did not breed or willingly perch on trees. But besides *C. livia*, with its geographical sub-species, only two or three other species of rock-pigeons are known; and these have not any of the characters of the domestic breeds. Hence the supposed aboriginal stocks must either still exist in the countries where they were originally domesticated, and yet be unknown to ornithologists; and this, considering their size, habits, and remarkable characters, seems improbable; or they must have become extinct in the wild state. But birds breeding on precipices, and good fliers, are unlikely to be exterminated; and the common rock-pigeon, which has the same habits with the domestic breeds, has not been exterminated even on several of the smaller British islets, or on the shores of the Mediterranean. Hence the supposed extermination of so many species having similar habits with the rock-pigeon seems a very rash assumption. Moreover, the several above-named domesticated breeds have been transported to all parts of the world, and, therefore, some of them must have been carried back again into their native country; but not one has become wild or feral, though the dovecot-pigeon, which is the rock-pigeon in a very slightly altered state, has become feral in several places. Again, all recent experience shows that it is difficult to get wild animals to breed freely under domestication

doubtfully inclined to believe ...

... of the fowl alive having bred and crossed them and examined their skeletons it appears to me almost certain that all are the descendants of the wild Indian fowl *Gallus bankiva* and this is the con...

... s of which differ much from each other the evidence is clear that they are all descended from the common wild duck and rabbit

The doctrine of the origin of our several domestic races from several aboriginal stocks has been carried to an absurd extreme by some authors They believe that every race which breeds true let the distinctive characters be ever so slight has had its wild prototype ...

... formerly existed eleven wild species of sheep peculiar to Great Britain! When we bear in mind that Britain has now not one peculiar mammal and France but few distinct from those of Germany and so with Hungary Spain &c but that each of these kingdoms possesses several peculiar breeds of cattle sheep &c we must admit that many domestic breeds must have originated in Europe for whence otherwise could they have been derived? So it is in India Even in the case of the breeds of the domestic dog throughout the world which I admit are descended from several wild species it cannot be doubted that there has been an immense amount of inherited variation for who will believe that animals closely resembling the Italian greyhound the bloodhound the bull dog pug dog or Blenheim spaniel &c —so unlike all wild Canidæ— ever existed in a state of nature? It has often been loosely said that all our races of dogs have been produced by the crossing of a few aboriginal species but by crossing we can only get forms in some degree intermediate between their parents and if we account for our several domestic races by this process we must admit the former existence of the most extreme forms as the Italian greyhound bloodhound bull dog &c in the wild state Moreover the possibility of making distinct races by crossing has been greatly exaggerated Many cases are on record showing that a race may be modified by occasional crosses if aided by the careful selection of the individuals which present the desired character but to obtain a race intermediate between two quite distinct races would be very difficult Sir J Sebright expressly experimented with this object and failed The offspring from the first cross between two pure breeds is tolerably and sometimes (as I have found with pigeons) quite uniform in character and everything seems simple enough but when these mongrels are crossed one with another for several generations hardly two of them are alike and then the difficulty of the task becomes manifest

Breeds of the Domestic Pigeon their Differences and Origin

Believing that it is always best to study some special group I have after deliberation taken up domestic pigeons I have kept every breed which I could purchase or obtain and have been most kindly favoured with skins from several quarters of the world more especially by the Hon W Elliot from India and by the Hon C Murray from Persia Many treatises in different languages have been published on pigeons and some of them are very important as being of considerable antiquity I have associated with several eminent fanciers and have been permitted to join two of the London Pigeon Clubs The diversity of the breeds is something astonishing Compare the English carrier and the short faced tumbler and see the wonderful difference in their beaks entailing corresponding differences in their skulls The carrier more especially the male bird is also remarkable from the wonderful development of the carunculated skin about the head and this is accompanied by greatly elongated eyelids very large external orifices to the nostrils and a wide gape of mouth The short faced tumbler has a beak ...

... size with long massive beak and large feet some of the sub breeds of runts have very long necks others very long wings and tails others singularly short tails The barb is allied to the carrier but instead of a long beak has a very short and broad one The pouter has a much elongated body wings and legs and its enormously developed crop which it glories in inflating may well excite astonishment and even laughter The turbit has a short and conical

beak, with l e f ersed f thers down th f t has th hab t f continually

red to g t

form hood and t has, p port lly to ts ze longated w g d ta l f th s. Tl trumpeter a d laugh r th nam exp s, tl r a ry d ffere t coo from the th r b eed Th f l l has thirty ev n f rty tail

and are carried so ect, th good bird th h l d tail to h th l gland is q te borted Se l the l ss dist ct breed might be pec fied

I the k l t s f tl ral breed the de k pm t f th bo es f the f ce in le gth and breadth d curv ture d ff rs m u l The hape as w ll as th breadth and l gth of th ramus f th l w jaw aries n highly

relati f th t o a m f th fu c la. Tl proport al w dth of th g pe f m th, the proport nal l gtl f th l ds, f the orifice f th n trils, f tl to gu (t lw y tr t correlat th th l gth f beak) th size of tl e rop and f tl ppe p rt f tl sophagus tl d l pm t and bort f tl l gland th n mbe f tl primary wing and ca dal f th rs th lat l gth f the ing and tail to ach tl and to the body tl relati l gth f tl l g and foot the ml r f scut lle n th toes, th d el p t f kin bet ee tl toes, ar all po ts f

th g b rds are l thed wh n l t l ed Th hape an l size f th ggs ary Tl m f l t, and in some l eeds th ce and disposition, d ff remark l l Lastl ce tain breeds, the males and f mal com to l sl ght d gree f l tl

lish carr the h rt faced tumbler the runt, th b b pout r and fantail in the same genus m re pecially as n el f thes breeds se tal truly nh r ted ub-l eds n spec s as h would call them could be hown him

G at as are th diff rence b tw en th l eed of th p geon I am f lly conv nced that the common op m n f n turalists is correct, n m ly th t all are de cended f m th rock p geon (*C l mba li a*) incl ding und r tl s t rm eral geo rapl cal ces o sub species, wh ch d ff r fr m each th r in the m t tri fling respects A e l of the asons wh ch ha led m to th s b lief are in me d gree pplicabl n the cas s, I w ll h b efly give them If th se al b eeds e n t ari ties, and ha n t proceeded from the ock p geon, tl ey mu t ha d scended f om t l ast n ght borig nal tocks fo it s

possessed the char cte tic m us crop Th pposed borignal tocks mu t all h been ock p geons, that is th y did n t breed o willingly pe ch on trees. B t bes d *C l via* w th ts geogr phical b- pec s, only two thr e th r pecies f ock p geons ar kno n d th se h not any of th char ct f the d me t c b eeds H n the pposed aborig nal tocks mu t e tl till exi t n the un tries wh e th y w ri nally dome t cat d nd t be unknown t rnithologists and this con deri g th size h l ts, nd emarkabl har ct rs eems mp b ble r tl y mu t ha e become ext t n the wild t te t b rd b eeding n p ec p ces, and good fl a unlikely to be t rm n ted and the com m ock p geo whi h has th same hab ts with tl d m stic b eed has n t been ext r m ted on se ral f th sm lle B t sh *l ts,* *tl h re f th* Mediterran an Hence tl pposed extermi nat n f so m y pec s ha g milar hab ts w th the rock p geo eem ry ash ass mpti n. M o th se al b m d d mest c ted breed ha be n t ansport d to ll parts f th w ld d tl f som f tl m mu t ha b n arried back gai t tl nati co try b t n t n has become wild *f l,*

yet on the hypothesis of the multiple origin of our pigeons it must be assumed that at least seven or eight species were so thoroughly domesticated in ancient times by half-civilised man as to be quite prolific under confinement

An argument of great weight and applicable in several other cases is that the above specified breeds though agreeing generally with the wild rock pigeon in constitution habits voice colouring and in most parts of their structure yet are certainly highly abnormal in other parts we may look in vain through the whole great family of Columbidæ for a beak like that of the English carrier or that of the short faced tumbler or barb for reversed feathers like those of the Jacobin for a crop like that of the pouter for tail feathers like those of the fantail Hence it must be assumed not only that half-civilised man succeeded in thoroughly domesticating several species but that he intentionally or by chance picked out extraordinarily abnormal species and further that these very species have since all become extinct or unknown So many strange contingencies are improbable in the highest degree

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feral —these pec s pre nt g rtain v ry ab rmal charact s, as compar d w th all the Col mb dæ th gl a l ke th rock p geon most respects —th occ i al ppearance f th bl col and v rio s black ma ks ll th b eeds both when kept nd wl cr ssed —and lastly the mo grel ffspri g be g perfectly f rt le —f om tl ese se eral r as tak n t gethe we m y saf ly co l d tl at ll domest b eeds

that w u un u
of d mesticat m E rope a d in India and that ta ree hal ts and in gr at numbe f po ts f tructu ith ll th dome ti breeds. Seco dly that, lth gh an Engli h carr r a h rt faced tumbl d ffe m nsely in c r tain charact s f m the ock p g n, y t that, by comparing tl se l b-b eds f th se t races, m re e pecially tl os b gl t fr m distant co ntries an in k bet n th m and th ock p geon, lmo t p rf ct n s so w can in some oth case l t t w th ll the b eeds. Tl dly those l aracters wh ch are mainly d tinct e f ach breed ar each minently ariabl f tance tl w ttl and length f beak f the carr tl hort ess of that of th tumbl and tl n mbe f ta l f th rs in the f tail nd tl plan ti n of this fact ll be b ou wl w t eat f Se lecti n. F urthly p geons l e be w tched and tended th th utm t ca d l ed by many people Th y ha been dom ticat d for th usands f y ar n se l q arters of th w ld th earl t kn n reco l of p geons is in the fifth Ægypti dy asty bo t 3000 B.C as as po ted t t m by Professor Lepsius l t M B h f rm m th t p geons ar giv n a b ll f f re the pr vious dynasty In th tim f th R s, as

Khan in India, abo t the y ar 1600 n less than 20 000 p geons wer taken w th th court. "The monar h of Iran and T ran sent him some ry rare b rds and contin the

courtly h sto ian 'His M j sty by cro ing the breeds whi h m thod w s neve ctised b fo e has imp ved th m astonish ngly About this sam p riod th Dutch were s eag r ab t p ge ns as we e the old Rom ns Tl paramount importan e f these c ns de atio n xpl i ng the imm nse am unt f variat n which p g ons have und ne will like i b ob s wh n we t eat of Selection We hall then l ee h w it is th t the s v e l bre ds o ft n ha m what mon str u charact It is also a mo t f vou ble circum ta ce fo the p oduction of di t n t breeds, that male and f m le p geons can be asily m ted fo l fe and thus d ff r nt b eeds can be k pt togeth r in th same a iary

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cated th y had ll p oceed d from a comm n par nt, as any natur list co ld in coming to a similar con lus n in g d to the many spec es of f hes r oth r g ps of b ds, in nature On circumstance has truck me much name ly that n arly ll the b ders f th various d m ti animal and th cultivato f plants w th wh m I ha conve sed, or whose t eat I have d are firmly c n n d that tl e sev l b eds to wh h each has ttended are d sce ded f m many ab gin lly distinct speci sk, as I ha ask d a cel b ted ra s f He f d ttl wh the hi cattl m gl t n t ha d scen led f m l n h rns n both from a comm n pa nt tock d h w ll l gh y u to scorn I ha n t a p geon o po ltry r d ck, bb t f nci who was n t fully convin d th t h m in b ed was descended f m a disti t pecies Van M ns, in hi tr tise n pears and apples h w h w utt ly he d bel that the se l rts f r instance Rib ton p pp n r Codlin pple could ha p oceed d f m th seed of th same tr e Inn m bl th xamples co ld b g n. Th explanati I think is mple f m l g-contin ed st dy th y ar

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Some authors believe that long-continued domestication eliminates this strong tendency to sterility in species From the history of the dog and of some other domestic animals, this conclusion is probably quite correct if applied to species closely related to each other But to

spring perfectly fertile *inter se* would be rash in the extreme

From these several reasons, namely —the improbability of man having formerly made seven or eight supposed species of pigeons to breed freely under domestication —these supposed species being quite unknown in a wild state, and their not having become anywhere feral —these species presenting certain very abnormal characters, as compared with all other Columbidae, though so like the rock pigeon in most respects —the occasional reappearance of the blue colour and various black marks in all the breeds, both when kept pure and when crossed —and lastly the mongrel offspring being perfectly fertile —from these several reasons taken together we may safely conclude that all our domestic breeds are descended from the rock-pigeon or Columba livia with its geographical sub-species.

In favour of this view I may add, firstly that the wild C. livia has been found capable of domestication in Europe and in India and that it agrees in habits and in a great number of points of structure with all the domestic breeds. Secondly that, although an English carrier or short-faced tumbler differs immensely in certain characters from the rock-pigeon, yet that, by comparing the several sub-breeds of these two races, more especially those brought from distant countries, we can make between them and the rock-pigeon, an almost perfect series; so we can in some other cases, but not with all the breeds. Thirdly those characters which are mainly distinctive of each breed are in each eminently variable for instance the wattle and length of beak of the carrier the shortness of that of the tumbler and the number of tail-feathers in the fantail and the explanation of this fact will be obvious when we treat of Selection. Fourthly pigeons have been watched and tended with the utmost care and loved by many people. They have been domesticated for thousands of years in several quarters of the world the earliest known record of pigeons is in the fifth Ægyptian dynasty about 3000 B. C., as was pointed out to me by Professor Lepsius but Mr Birch informs me that pigeons are given in a bill of fare in the previous dynasty In the time of the Romans, as we hear from Pliny immense prices were given for pigeons "nay they are come to this pass, that they can reckon up their pedigree and race." Pigeons were much valued by Akber Khan in India, about the year 1600 not less than 20 000 pigeons were taken with the court. "The monarchs of Iran and Turan sent him some very rare birds and continues the courtly historian, "His Majesty by crossing the breeds, which method was never practised before has improved them astonishingly." About this same period the Dutch were as eager about pigeons as were the old Romans. The paramount importance of these considerations in explaining the immense amount of variation which pigeons have undergone will likewise be obvious when we treat of Selection. We shall then, also, see how it is that the several breeds so often have a somewhat monstrous character It is also a most favourable circumstance for the production of distinct breeds, that male and female pigeons can be easily mated for life and thus different breeds can be kept together in the same aviary

I have discussed the probable origin of domestic pigeons at some, yet quite insufficient, length because when I first kept pigeons and watched the several kinds, well knowing how truly they breed, I felt fully as much difficulty in believing that since they had been domesticated they had all proceeded from a common parent, as any naturalist could in coming to a similar conclusion in regard to the many species of finches, or other groups of birds, in nature. One circumstance has struck me much namely that nearly all the breeders of the various domestic animals and the cultivators of plants, with whom I have conversed, or whose treatises I have read, are firmly convinced that the several breeds to which each has attended, are descended from so many aboriginally distinct species. Ask, as I have asked, a celebrated raiser of Hereford cattle whether his cattle might not have descended from long horns, or both from a common parent-stock, and he will laugh you to scorn. I have never met a pigeon or poultry or duck, or rabbit fancier who was not fully convinced that each main breed was descended from a distinct species. Van Mons, in his treatise on pears and apples, shows how utterly he disbelieves that the several sorts, for instance a Ribston pippin or Codlin-apple could ever have proceeded from the seeds of the same tree Innumerable other examples could be given. The explanation, I think, is simple from long-continued study they are strongly impressed with the differences between the several races and though they well know that each race varies slightly for they win their prizes by selecting such slight differences, yet they ignore all general arguments, and refuse to sum up in their minds slight differences accumulated during many successive generations. May not those naturalists who, knowing

far less of the laws of inheritance than does the breeder and knowing no more than he does of the intermediate links in the long lines of descent yet admit that many of our domestic races are descended from the same parents—may they not learn a lesson of caution when they deride the idea of species in a state of nature being lineal descendants of other species?

Principles of Selection anciently followed and their Effects

Let us now briefly consider the steps by which domestic races have been produced either from one or from several allied species Some effect may be attributed to the direct and definite action of the external conditions of life and some to habit but he would be a bold man who would account by such agencies for the differences between a dray and race horse a greyhound and bloodhound a carrier and tumbler pigeon One of the most remarkable features in our domesticated races is that we see in them adaptation not indeed to the animal s or plant s own good but to man s use or fancy Some variations useful to him have probably arisen suddenly or by one step many botanists for instance believe that the fuller s teasel with its hooks which cannot be rivalled by any mechanical contrivance is only a variety of the wild *Dipsacus* and this amount of change may have suddenly arisen in a seedling So it has probably been with the turnspit dog and this is known to have been the case with the ancon sheep But when we compare the dray horse and race horse the dromedary and camel the various breeds of sheep fitted either for cultivated land or mountain pasture with the wool of one breed good for one purpose and that of another breed for another purpose when we compare the many breeds of dogs each good for man in different ways when we compare the game cock so pertinacious in battle with other breeds so little quarrelsome with everlasting layers which never desire to sit and with the bantam so small and elegant when we compare the host of agricultural culinary orchard and flower garden races of plants most useful to man at different seasons and for different purposes or so beautiful in his eyes we must I think look further than to mere variability We cannot suppose that all the breeds were suddenly produced as perfect and as useful as we now see them indeed in many cases we know that this has not been their history The key is man s power of accumulative selection nature gives successive variations man adds them up in certain directions useful to him In this sense he may be said to have made for himself useful breeds

The great power of this principle of selection is not hypothetical It is certain that several of our eminent breeders have even within a single lifetime modified to a large extent their breeds of cattle and sheep In order fully to realise what they have done it is almost necessary to read several of the many treatises devoted to this subject and to inspect the

from highly competent authorities Youatt who was probably better acquainted with the works of agriculturists than almost any other individual and who was himself a very good judge of animals speaks of the principle of selection as that which enables the agriculturist not only to modify the character of his flock but to change it altogether It is the magician s wand by means of which he may summon into life whatever form and mould he pleases Lord Somerville speaking of what breeders have done for sheep says — It would seem as if they had chalked out upon a wall a form perfect in itself and then had given it existence In Saxony the importance of the principle of selection in regard to merino sheep is so fully recognised that men follow it as a trade the sheep are placed on a table and are studied like a picture by a connoisseur this is done three times at intervals of months and the sheep are each time marked and classed so that the very best may ultimately be selected for breeding

What English breeders have actually effected is proved by the enormous prices given for animals with a good pedigree and these have been exported to almost every quarter of the world The improvement is by no means generally due to crossing different breeds all the best breeders are strongly opposed to this practice except sometimes amongst closely allied sub breeds And when a cross has been made the closest selection is far more indispensable even than in ordinary cases If selection consisted merely in separating some very distinct variety and breeding from it the principle would be so obvious as hardly to be worth notice but its importance consists in the great effect produced by the accumulation in one direction during successive generations

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Th same p incipl are f ll ed by h t cult rists b t the ariat ns e l e ften m re abrupt S ppose that h ce t

thus, t gi a ry t fling nstance th t adily creasing ze f th comm n goose berry m y be q ted W see an t m h ng impro m t in many fl t fl w wh n th fl w rs f th p ese t d y ar comp red w th dr ing m d ly tw nty thi ty y ar go. Wh n a ace f plants is ce pret ty ll tablished, th eed ai rs do n t p k t th be t plants, b t m rel g th ir seed beds, and p ll p th gu s, as

w t animals.

In regard to plants, ther is an th m ans f observing th accumulated ffects f selec ti —nam l b comparing th di rs t f fl ers in th diff rent ari ti f th sam pecie in th fl w gard n th di rs t f lea es, pods, t bers, what part is al ed, in th kit h gard n, in comparison with th flow rs f th sam ari ties and th di ersity of fruit f th sam species n th chard, in compariso with th l es and flo ers of th sam set of ari ties. See how differe t th lea es f th cabbag ar and h w trem l alik th fl w rs h w unlik th flowers f th heartsease are and h w alik the lea es how m ch th fru t f th diff rent kinds of gooseberries diff in size, col ur shape, and hairiness, and t th flow rs p se t ry light diff re ces It is n t that th arieties hich differ lar l in som point do not differ at all in the points this is hard

ly e e —I sp k aft r ca eful observati n — pe l p ne the cas The law f corr lated ar ti n, tl e mportan e of whicl sh ild n r be o erlook d w ll n u e som d ff r n e h t, a gene al rul t cannot l do bted that th contin ed l ction of l gl t iat o s tl n tl l the fl w r or the fru t, w ll p od c ces differing from e h oth r hi fly in tl ese chara t rs

It m y be by ted that the p inc ple f se lect on has be n reduced to methodical prac t c f r scarcely m re tl an th e-quart rs f a c ntury t h ce t nly been more tt nded t f l te year d m ny tr t se ha e be n p bl hed n the bject nd tl s lt l as be n in a co e j d g d g ee rapid and m portant. B t t ry f f m tru that the p inc pl is a mode n d co e v I c ld g e s l f e to w ks of high antiquit in which th f ll mportance f the p c ple is ackn wledged In rude nd barb rous pe riod f Engl h h t rv h ce an mal we oft n imp ted, d l w w e passed to pre t th xp rtat n the de truction f hors s u d r ce ta z was d red and thus m y b comp red to th oguing f

passag n G es t is cl ar th t the col r f d m tic an mals was at that arly p od attended t S g w om t mes cross th ird g w th w ld ca ine an mals, to imp o th breed, and th f m ly did so, as is at tested by passage n Pliny The sav ge n So th Af ca m tch th draught cattl by col as d som f th Esquimaux th team of d g La ng t e states that good d mesti b eed h ghly al ed by th n groes n th int n f Africa wh ha n t associ ted w th Eu pean Som f th se f ct d n t h w l lecti n, but th y h w that th b eeding f d m t c animals was car fully tt nded t in anci t t mes and n w tt ded t by th l w t sa g s It w ld indeed, h been a strang f ct, had tt nt on t been p d t breeding f th inh ritance f good and b d qu lities in so bvi us.

Uncons ous Selection

At th p esent tim min nt b eeders try by m thodical selecti n, w th di tin bject in w to mak new train ub-b eed u peri to anythin of th kind in th country

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at the wonderf l skill of gardeners, in ha ing produced such splendid results from such poo materials b t th art has been simple, and, as far as th final s lt is concerned has been f llo ed almost unconsc ly It has con sisted in al y cultivating the be t known variet sowing ts seeds, and, wh n a l ghtly better vari ty chanced to ppear s. ecting t, and so onwards. B t the garden s f th class-ical period wh ulti ted th best pears hich they co ld p ocure, n r tho ght what sple did fruit w hould eat th ugh w o our xcellent fruit in som small d gree to their having naturally chosen and p eserved the best arieties th y could anywh find.

A larg amount f change, thus slowly and unconsciously accumulated explains, as I be-lie e, the well kn wn fact, that in a numbe of cases we cann t ecognise, and th refo d ot kn w th wild parent tocks f th pla ts which ha bee l gest cult ted in ou flow r and k tch n gard ns If t has tak n centuries th sand of y ars t mpro modify most f plants p to th ir present standard f sef lness t man we can unde stand how t i that n th Au tralia, the Cape f Good H pe any oth r g n in hab ted by quit unci lised man, has aff rded us singl plant w rth cult It is n t that these countries, so rich in species, d n t by a strange chance possess th aboriginal tocks of any useful plants, b t that th nat plants ha not been impro ed by co tinued selec-tion p to a tandard f perfecti n comparable th that acq red b th plant in countries anciently ci ilised

In regard to th d mesti animals k pt by unci ilised man, t h uld n t be o looked that th y almost alw ys ha to truggl for their own food t l ast during certain seasons. And in tw countries ry diff ntly circum tanced, ind d als f th sam spec es, ha ing slightly diff t constit ti ns tru t re would oft ceeded bette th co try than in th th and thus by process of natural selecti n, as will b reaft be m re f lly xplained, tw sub-breeds m ght be f rm ed. This, pe haps, partly xplains why th arieties k pt by sa ges, as has been e-marked by som th rs, ha m re f th charact of tru species than th ari t es kept in ci ilised countri s.

On th w h re g f th mportant part which selecti by man has played t be-comes t ce ob s, h w t is that ur do-mestic races show adaptation in thei tructure r in their hab ts to man s wants or fancies. W can, I think furth r understand th fre q ntly abn rmal characters of our d mestic races, and l k wise the r differences be g so gre t in e t rnal charact rs nd latively so l ght in i t rnal parts or or ans. Man can hardly select, o nly with n h difficulty any d t n of truct xcepting cl as is xternally sible and indeed he rarely cares for what is internal He can ne er act by selec-ti n excepti g n variatio s which ar first g an to him som sl ght d gree by n ture No man w ld er try t make a fanta l tail h saw a p geo w th a tail de l ped in some l l t l gree in an unu u l mann r or pouter

us un —

B t to use uch an expres n as try g to m k a fantail, is, I ha e no doubt, most

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p geon w ld become thro h long-continued partly unco sci s and partly m thodical, se-lecti n. Perhap the parent-bird f all fantails had only f urteen tail feathers somewhat ex panded, lik th present J va fantail, or lik indi duals of oth and dist ct breeds, in which as many as se enteen tail f athers ha n

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ci rs, as t is n t n f the points f the breed

N l t t be tho ght that som great de ation f tru t re would be necessary to catch th fancier ey h perceives e tr m ly mall differences, and t is in h man nat t al any n lty h w r slight, in own pos sessi n. N must th v l which wo ld for m y been set n any slight differences n th indi d ls f th same species, b j dged f by th alue which is n w set on them aft se ral breeds ha f irly been established. It is known that with p geons many l ght ariati ns n w occasi nally p-pear b t these are rejected as f ults d ti ns from th tandard f perfection in each breed. The comm n goose has n t g en rise to any marked ari t es hence th T louse and th comm n breed which diffe only in colour that most fleeting of charact rs, have lately been exhib ted as distinct at ur poultry shows.

But for our purpose a form of Selection which may be called Unconscious and which results from every one trying to possess and breed from the best individual animals is more important Thus a man who intends keeping pointers naturally tries to get as good dogs as he can and afterwards breeds from his own best dogs but he has no wish or expectation of permanently altering the breed Nevertheless we may infer that this process continued during centuries would improve and *modify any breed in the same way as* Bakewell Collins &c by this very same process only carried on more methodically did greatly modify even during their lifetimes the forms and qualities of their cattle Slow and insensible changes of this kind can never be recognised unless actual measurements or careful drawings of the breeds in question have been made long ago which may serve for comparison In some cases however unchanged or but little changed individuals of the same breed exist in less civilised districts where the breed has been less improved There is reason to believe that King Charles s spaniel has been unconsciously modified to a large extent since the time of that monarch Some highly competent authorities are convinced that the setter is directly derived from the spaniel and has probably been slowly altered from it It is known that the English pointer has been greatly changed within the last century and in this case the change has it is believed been chiefly effected by crosses with the foxhound but *what concerns us is* that the change has been effected unconsciously and gradually and yet so effectually that though the old Spanish pointer certainly came from Spain Mr Borrow has not seen as I am informed by him any native dog in Spain like our pointer

By a similar process of selection and by careful training English race horses have come to surpass in fleetness and size the parent Arabs so that the latter by the regulations *for the Goodwood Races* are favoured in the weights which they carry Lord Spencer and others have shown how the cattle of England have increased in weight and in early maturity compared with the stock formerly kept in this country By comparing the accounts given in various old treatises of the former and present state of carrier and tumbler pigeons in Britain India and Persia we can trace the stages through which they have insensibly passed *and come to differ so greatly from the rock* pigeon

Youatt gives an excellent illustration of the effects of a course of *selection* which *may* be considered as unconscious in so far that the breeders could never have expected or even wished to produce the result which ensued—namely the production of two distinct strains The two flocks of Leicester sheep kept by Mr Buckley and Mr Burgess as Mr Youatt remarks have been purely bred from the original stock of Mr Bakewell for upwards of fifty years There is not a suspicion existing in the *mind of any one at all acquainted with the* subject that the owner of either of them has deviated in any one instance from the pure blood of Mr Bakewell s flock and yet the difference between the sheep possessed by these two gentlemen is so great that they have the appearance of being quite different varieties

If there exist savages so barbarous as never to think of the inherited character of the offspring of their domestic animals yet any one animal particularly useful to them for any special purpose would be carefully preserved *during famines and other accidents* to which savages are so liable and such choice animals would thus generally leave more offspring than the inferior ones so that in this case there would be a kind of unconscious selection going on We see the value set on animals even by the barbarians of Tierra del Fuego by their killing and devouring their old women in times of dearth as of less value than their dogs

In plants the same gradual process of improvement through the occasional preservation of the best individual whether or not sufficiently distinct to be ranked at their first appearance as distinct varieties and whether or not two or more species or races have become blended together by crossing may plainly be recognised in the increased size and beauty which we now see in the varieties of the heartsease rose pelargonium dahlia and *other plants* when compared with the older varieties or with their parent stock No one would ever expect to get a first rate heartsease or dahlia from the seed of a wild plant No one would expect to raise a first rate melting pear from the seed of the wild pear though he might succeed from a poor seedling growing *wild if it had come from a garden stock* The pear though cultivated in classical times appears from Pliny s description to have been a fruit of very inferior quality I have seen great surprise expressed in horticultural works

o maize probably differ more in s e, than do th seeds of the distinct spe es in any n g n in th same two fam l s. The sam e- m k h ld good in re ard to th fru t of the ml n t f th plum and till more

the animal has been urprisingly mod ed u impro ed b caref l select n in pe cocks, from not bein ry asily ared and large r k t l t eese, from being alu ble

ti ns e as
causi g ariab lit both b acting directly on th o gan sation, and ind rectly by affectin th reprod ti y t m It is n t p l bl th t ari b lity m an nl rent and necessary conting nt, und ll circum tances. The gr at r r less f rce of inheritance and rsi n, d t rm in wh th variat n hall end re Va

singularly infl xibl ganisati n, th ugh t has varied to slight xtent, as I ha elsewh re descr bed.

Some thors ha maintained that the amount of ariati n in d m tic p odu tions is soo reach d, and can n aft ards be exceeded. It w ld be som what ra h to assert that th limit has been ttained in any

we do n all
d finit act n f the conditi ns of l f Some, pe haps a gre t ffect may be attributed to th increased se d use f parts. The final result thu rendered nfinitely compl x In

instance th re must be limit t th fleetness of any t rrestrial animal, as this w ll be d t mined b th fri ti n t be room th we ght f body to be carried, and th pow of contracti in th m scular fibres. B t what concerns us is that th d mesti ari ti f the sam species d ff f m h th in l most ery chara te which man has tt ded to and selected m re than d th distinct spe cies f th sam g ra I d Geoff y St Hilaire has pro ed this in regard t ize and so t is th col and probably w th th length f ha W th re pect t fleetn ss, whi h depends an bodil hara t rs, Eclipse as far fleet and d h rse unco par ably t than an t nat ral species belonging t th sam us So w th plants, the se ds f th diff rent ari ties f the bean

country th occasional int crossing, w th th id f selecti n, has, no d bt, larg ly aid ed n th f rmati n f new sub-breeds b t th mportance of crossin has been much ag rated both in regard to animals and to those plants which are p pagated by seed W th plants whi h ar temporarily propagated by cutti gs, b ds, &c. th importance f cross- n is immense f r th cult ator may h

f littl mportance t us, fo their nd rance is nl t mporary O all these causes f Chan e, th accum lati ti n of Selecti n, wheth ppl ed m thodically and quickl o nconsci sly and l wly b t m re ffi tly seem t ha been th pred *minant* P

These views appear to explain what has sometimes been noticed—namely that we know hardly anything about the origin or history of any of our domestic breeds But in fact a breed like a dialect of a language can hardly be said to have a distinct origin A man preserves and breeds from an individual with some slight deviation of structure or takes more care than usual in matching his best animals and thus improves them and the improved animals slowly spread in the immediate neighbourhood But they will as yet hardly have a distinct name and from being only slightly valued their history will have been disregarded When further improved by the same slow and gradual process they will spread more widely and will be recognised as something distinct and valuable and will then probably first receive a provincial name In semi civilised countries with little free communication the spreading of a new sub breed would be a slow process As soon as the points of value are once acknowledged the principle as I have called it of unconscious selection will always tend —perhaps more at one period than at another as the breed rises or falls in fashion —perhaps more in one district than in another according to the state of civilisation of the inhabitants —slowly to add to the characteristic features of the breed whatever they may be But the chance will be infinitely small of any record having been preserved of such slow varying and insensible changes

Circumstances favourable to Man s Power of Selection

*I will now say a few words on the circum*stances favourable or the reverse to man s power of selection A high degree of variability is obviously favourable as freely giving the materials for selection to work on not that mere individual differences are not amply sufficient with extreme care to allow of the accumulation of a large amount of modification in almost any desired direction But as variations manifestly useful or pleasing to man appear only occasionally the chance of their appearance will be much increased by a large number of individuals being kept Hence number is of the highest importance for success.

al ... proved On the other hand nurserymen from keeping large stocks of the same plant are generally far more successful than amateurs in raising new and valuable varieties A large number of individuals of an animal or plant can be reared only where the conditions for its propagation are favourable When the individuals are scanty all will be allowed to breed whatever their quality may be and this will effectually prevent selection But probably the most important element is that the animal or plant should be so highly valued by man that the closest attention is paid to even the slightest deviations in its qualities or structure Unless such attention be paid nothing can be effected I have seen it gravely remarked that it was most fortunate that the strawberry began to vary just when gardeners began to attend to this plant No doubt the strawberry had always varied since it was cultivated but the slightest varieties had been neglected As soon however as gardeners picked out individual plants with slightly larger earlier or

is an important element in the formation of new races —at least in a country which is already stocked with other races *In this respect* enclosure of the land plays a part Wandering *savages or the inhabitants of open plains rarely* possess more than one breed of the same species Pigeons can be mated for life and this is a great convenience to the fancier for thus *many races may be improved and kept true* though mingled in the same aviary and this circumstance must have largely favoured the formation of new breeds Pigeons I may add can be propagated in great numbers and at a very quick rate and inferior birds may be freely rejected as when killed they serve for food On the other hand cats from their nocturnal rambling habits cannot be easily matched and although so much valued by women and children we rarely see a distinct breed long kept up such breeds as we do sometimes see are almost always imported from some other country Although I do not doubt that some domestic animals vary less than others yet the rarity or absence of distinct breeds of the cat the donkey peacock goose &c may be attributed in main part to selection not having been brought into play in cats from the difficulty in pairing them in donkeys from only a

in many specimens of the same species. It would never have been expected that the branching of the main nerves close to the great ... of an insect would have been lace ject, pec ago con p c ... termed t ... arieties. Fritz Müller has described analogous but more extraordinary cases

of a tem ... tree ... ist, I may add, has also shown that the muscles in the larvae of certain insects are far from uniform. Authors sometimes argue in a circle when they state that important organs never vary; for these same authors practically rank those parts as important (as some few naturalists have honestly confessed) which do not vary; and, under this point of view, no instance will ever be found of an important part varying; but under any other point of view many instances assuredly can be given.

There is one point connected with individual differences, which is extremely perplexing: I refer to those genera which have been called "protean" or "polymorphic," in which the species present an inordinate amount of variation. With respect to many of these forms, hardly two naturalists agree whether to rank them as species or as varieties. We may instance *Rubus*, *Rosa*, and *Hieracium* amongst plants, several genera of insects and of brachiopod shells. In most polymorphic genera some of the species have fixed and definite characters. Genera which are polymorphic in one country seem to be, with a few exceptions, polymorphic in other countries, and likewise, judging from brachiopod shells, at former periods of time. These facts are very perplexing, for they seem to show that this kind of variability is independent of the conditions of life. I am inclined to suspect that we see, at least in some of these polymorphic genera, variations which are of no service or disservice to the species, and which consequently have not been seized on and rendered definite by natural selection, as hereafter to be explained.

Individuals of the same species often present, as is known to every one, great differences of structure, independently of variation, as in the two sexes of various animals, in the two or three castes of sterile females or workers amongst insects, and in the immature and larval states of many of the lower animals. There are also, cases of dimorphism and trimorphism, both with animals and plants. Thus, Mr. Wallace

Of these cases, the two or three forms, both with animals and plants are not now connected by intermediate gradations, it is probable that they were once thus connected. Mr. Wallace, for instance, describes a certain butterfly which presents in the same island a great range of ... connected by ... termed ... links, and the extreme links of the chain closely resemble the two forms of an allied dimorphic species inhabiting another part of the Malay Archipelago. Thus also with ants, the several worker castes are generally quite distinct; but in some cases, as we shall hereafter see, the castes are connected together by finely graduated varieties. So it is, as I myself observed, with some dimorphic plants. It certainly at first appears a highly remarkable fact that the same female butterfly should have the power of producing at the same time three distinct female forms and a male; and that an hermaphrodite plant should produce from the same seed-capsule three distinct hermaphrodite forms, bearing

... of ... that the female produce offspring of two sexes ... sometimes differ from each ... in ... wonderful manner.

Doubtful Species

The forms which possess in some considerable degree the character of species, but which are so closely similar to other forms, or are so closely linked to them by intermediate gradations, that naturalists do not like to rank them as distinct species, are in several respects the most important for us. We have every reason to believe that many of these doubtful and closely allied forms have permanently retained their characters for a long time; for as long, as far as we know, as have good and true species. Practically, when a naturalist can unite by means of intermediate links any two forms, he

CHAPTER II

VARIATION UNDER NATURE

Before applying the principles arrived at in the last chapter to organic beings in a state of nature we must briefly discuss whether these latter are subject to any variation. To treat this subject properly a long catalogue of dry facts ought to be given but these I shall reserve for a future work. Nor shall I here discuss the various definitions which have been given of the term species. No one definition has satisfied all naturalists yet every naturalist knows vaguely what he means when he speaks of a species. Generally the term in

of descent is almost universally implied though it can rarely be proved. We have also what are called monstrosities but they graduate into varieties. By a monstrosity I presume is meant some considerable deviation of structure generally injurious or not useful to the species. Some authors use the term variation in a technical sense as implying a modification directly due to the physical conditions of life and variations in this sense are supposed not to be inherited but who can say that the

far northerly would not in some cases be inherited for at least a few generations? And in this case I presume that the form would be called a variety.

It may be doubted whether sudden and considerable deviations of structure such as we occasionally see in our domestic productions

fully related to its complex conditions of life that it seems as improbable that any part should have been suddenly produced perfect as that a complex machine should have been invented by man in a perfect state. Under domestication monstrosities sometimes occur which resemble normal structures in widely different animals. Thus pigs have occasionally been born with a sort of proboscis and if any wild species of the same genus had naturally possessed a proboscis it might have been argued that this had appeared as a monstrosity but I have as yet failed to find after diligent search cases of monstrosities resembling normal structures in nearly allied forms and these alone bear on the question. If monstrous forms of this kind ever do appear in a state of nature and are capable of reproduction (which is not always the case) as they occur rarely and singularly their preservation would depend on unusually favourable circumstances. They would also during the first and succeeding generations cross with the ordinary form and thus their abnormal character would almost inevitably be lost. But I shall have to return in a future chapter to the preservation and perpetuation of single or occasional variations.

Individual Differences

The many slight differences which appear in the offspring from the same parents or which it may be presumed have thus arisen from being observed in the individuals of the same species inhabiting the same confined locality may be called individual differences. No one supposes that all the individuals of the same

afford materials for natural selection to act on and accumulate in the same manner as man accumulates in any given direction individual

that parts which must be called important whether viewed under a physiological or classificatory point of view sometimes vary in the individuals of the same species. I am convinced that the most experienced naturalist would be surprised at the number of the cases of variability even in important parts of structure which he could collect on good authority as I have collected during a course of years. It should be remembered that systematists are far from being pleased at finding variability in important characters, and that there are not many men who will laboriously examine internal and important organs and compare them

them as d t ct pec b t wh t d tance t has bee ll as ed, ll ffice f th t be t ee Am ric and E rop r ampl w ll th t bet ee E rope and th Az s, Mad ra, or tl Canar es, between th se e l sl ts f these mall archipela s, h ffic e t

M B D Walsh, d tinguished ntom logist of the U n ted Stat s, l descr bed what h call phytopl n t d phyto-phagi spec M t v g tabl feeding insects h k d f plant n ne gro p f plant som feed discrim t l ma y kinds, b t d t a conseq n ars In ral ases, h nsects f und h g n d ff re t plants, h e been b ed by Mr Walsh t prese t m tl lar al m t re state, in both t tes, light tl l nstant d ff rences col si e, n th n t re f the secret ns. In som in tance th m le lo in th tance b th mal d fe-mal s, l bee bserved th to d ff n a light d gee Wh tl d ff re ce re r th m tro gl m ked nd wh b th se l ll re ffected, th f m anked

mere usel ss al t act n mpl ing and assum ng p t act f r at n It certain that many f ms, cons de ed by h ghly-compet t j dg t b ariet e embl pecies so com plet ly n l ract th t they ha been thus r nked by tl h ghly-compete t judg s But t discuss h th th v ught to be called spe r ari t s, b fore any d finit n of th e te ms has been g n rally acc pted nly to b t th air

Many of tl e ases f t gly marked va i t s d btf l pec es w ll deserve cons de a t f r se r l t re t ng lines f arg m nt, from geog phic l d st but analog cal a l f l m &c l been bro gl t to

n d ubt br g t al ts to ag ee l n to ank d btful f ms. Y t t mu t b co f ssed th t t the b t k wn count e th t e find th gre t t n mb f th m I ha e been tru k with th fact, th t f any an m l o plant tat f nat re b h ghly u f l to man r from any l sely tt a t l s t t l ar t s f t w ll lm st un ersally l f d ecorded Th var t m reo

cross, as t an l th wl h ppe t ha lost th po as pec k th d ff nee d pe d th in eet l g l ng fed n d t t pla ts, t can t l xpected tl t in termed t l ks co ectin th se l f ms sh ld l f d Tl t l t tl l se has be t gu d d t m g wl tl to rank d btf l f as n t pec Tl lik se e ssa l occ tl l sel alled ganis s, l h l b t d t t tin ts la l Wl tl th h d an m l p la t g tl sam co t t h f t m lar d m tl sam rel pel go, ld prese ts d ff re t f m th d ff t ar a th al good l ance th t unt m l t f rm ll be d sco red wh h ll link t tl tl trem tates d th ar tl d g aded t tl ank f n t s.

S m f w t al ts m tar tl t an mal prese t n t b t th these m nat lists k tl l ght t d ff re ce f pe f l d wh th sam d t cal t tl t d tant co tr s, m t g ol ical f mat ns, th y b l th t t d t t pec l ld d th sam dress. Th t m pec thus com to be a

m re than d n pec t of f ms, wl ch a lm t u sally co d red by oth b t ts t b t and n thus co try tl e

pec m re t

I m y l ll d t a remarkabl m m l t l p bl led b A d Cand ll n th oaks f th wh l ld r had more mpl n t ls f tl d scrimin t n f tl pec s, co ld h ked n th m th

th rel t f l f th n t He pec fi bo d ch act rs wh h m y b f d rs n th sam b h som t ccord g t g d l pm t som t m tl t any ass nabl reason S ch l act rs re t f co se f pecific al b t th y as Asa G y has remarked n com l th m ir ch as g ally nt t pec fi d h t ns. D Ca d ll th n goe n t say th t h g es th ank f pec es to th f rms that diff r by charact

treats the one as a variety of the other ranking the most common but sometimes the one first described as the species and the other as the variety But cases of great difficulty which I will not here enumerate sometimes arise in deciding whether or not to rank one form as a variety of another even when they are closely connected by intermediate links nor will the commonly assumed hybrid nature of the intermediate forms always remove the difficulty In very many cases however one form is ranked as a variety of another not because the intermediate links have actually been found but because analogy leads the observer to suppose either that they do now somewhere exist or may formerly have existed and here a wide door for the entry of doubt and conjecture is opened

Hence in determining whether a form should

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jority of naturalists for few well marked and well known varieties can be named which have not been ranked as species by at least some competent judges

That varieties of this doubtful nature are far from uncommon cannot be disputed Compare the several floras of Great Britain of France or of the United State drawn up by different botanists and see what a *surprising number of* forms have been ranked by one botanist as good species and by another as mere varieties Mr H C Watson to whom I lie under deep *obligation for assistance of all kinds* has marked *for me 182 British plants which are* generally considered as varieties but which have all been ranked by botanists as species and in making this list he has omitted many trifling varieties which nevertheless have been ranked by some botanists as species and he has entirely omitted several highly polymorphic genera Under genera including the most polymorphic forms Mr Babington gives 251 species whereas Mr Bentham gives only 112 —a difference of 139 doubtful forms! Amongst animals which unite for each birth and which are highly locomotive doubtful forms ranked by one zoologist as a species and by another as a variety can rarely be found within the same country but are common in separated areas How many *of the birds and* insects in North America and Europe which differ very slightly from each other have been ranked by one eminent naturalist as undoubted species and by another as varieties or as they are often called geographical races! Mr Wallace in several *valuable papers on the various* animals especially on the Lepidoptera inhabiting the islands of the great Malayan archipelago shows that they may be classed under four heads namely as variable forms as local forms as geographical races or sub species and as true representative species The first or variable forms vary much within the limits of the same island The local forms are moderately constant and distinct in each separate island but when all from the several islands are compared together the differences are seen to be so slight and graduated that it is impossible to define or describe them though at the same time the extreme forms are sufficiently distinct The geographical races or sub species are local forms completely fixed and isolated but as they do not differ from each other by strongly marked and important characters there is no possible test but individual opinion to determine which of them shall be considered as species and which as varieties Lastly representative species fill the same place in the natural economy of each island as do the local forms and sub species but as they are distinguished from each other by a greater amount of difference than that between the local forms and sub species they are almost universally ranked by naturalists as true species *Nevertheless no certain criterion can* possibly be given by which variable forms, local forms sub species and representative species can be recognised

Many years ago *when comparing* and seeing *others compare the birds from the closely* neighbouring islands of the Galapagos Archipelago one with another and with those from the American mainland I was much struck how entirely vague and arbitrary is the distinction between species and varieties On the islets of the little Madeira group there are many insects which are characterized as varieties in Mr Wollaston's admirable work but which would certainly be ranked as distinct species by many entomologists Even Ireland has a few animals now generally regarded as varieties but which have been ranked as species

species whereas the greater number rank it as an undoubted species peculiar to Great Britain A wide distance between the homes of two doubtful forms leads many naturalists to rank

known to be the case by Mr. Wollaston with the varieties of certain fossil land-shells in Madeira, and with plants by Gaston de Saporta. If a variety were to flourish so as to exceed in numbers the parent species, it would then rank as the species, and the species as the variety; or it might come to supplant and exterminate the parent species; or both might co-exist, and both rank as independent species. But we shall hereafter return to this subject.

From these remarks it will be seen that I look at the term species as one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other, and that it does not essentially differ from the term variety, which is given to less distinct and more fluctuating forms. The term variety, again, in comparison with mere individual differences, is also applied arbitrarily, for convenience' sake.

Wide-ranging, much diffused, and common Species vary most.

Guided by theoretical considerations, I thought that some interesting results might be obtained in regard to the nature and relations of the species which vary most, by tabulating all the varieties in several well-worked floras. At first this seemed a simple task; but Mr. H. C. Watson, to whom I am much indebted for valuable advice and assistance on this subject, soon convinced me that there were many difficulties, as did subsequently Dr. Hooker, even in stronger terms. I shall reserve for a future work the discussion of these difficulties, and the tables of the proportional numbers of the varying species. Dr. Hooker permits me to add that after having carefully read my manuscript, and examined the tables, he thinks that the following statements are fairly well established. The whole subject, however, treated as it necessarily here is with much brevity, is rather perplexing, and allusions cannot be avoided to the 'struggle for existence,' 'divergence of character,' and other questions, hereafter to be discussed.

Alphonse de Candolle and others have shown that plants which have very wide ranges generally present varieties; and this might have been expected, as they are exposed to diverse physical conditions, and as they come into competition (which, as we shall hereafter see, is an equally or more important circumstance) with different sets of organic beings. But my tables further show that, in any limited country, the species which are the most common, that is abound most in individuals, and the species which are most widely diffused within their own country (and this is a different consideration from wide range, and to a certain extent from commonness), oftenest give rise to varieties sufficiently well marked to have been recorded in botanical works. Hence it is the most flourishing, or, as they may be called, the dominant species,—those which range widely, are the most diffused in their own country, and are the most numerous in individuals,—which oftenest produce well-marked varieties, or, as I consider them, incipient species. And this, perhaps, might have been anticipated; for, as varieties, in order to become in any degree permanent, necessarily have to struggle with the other inhabitants of the country, the species which are already dominant will be the most likely to yield offspring, which, though in some slight degree modified, still inherit those advantages that enabled their parents to become dominant over their compatriots. In these remarks on predominance, it should be understood that reference is made only to the forms which come into competition with each other, and more especially to the members of the same genus or class having nearly similar habits of life. With respect to the number of individuals or commonness of species, the comparison of course relates only to the members of the same group. One of the higher plants may be said to be dominant if it be more numerous in individuals and more widely diffused than the other plants of the same country, which live under nearly the same conditions. A plant of this kind is not the less dominant because some conferva inhabiting the water or some parasitic fungus is infinitely more numerous in individuals and more widely diffused. But if the conferva or parasitic fungus exceeds its allies in the above respects, it will then be dominant within its own class.

Species of the Larger Genera in each Country vary more frequently than the Species of the Smaller Genera.

If the plants inhabiting a country, as described in any Flora, be divided into two equal masses, all those in the larger genera (i.e., those including many species) being placed on one side, and all those in the smaller genera on the other side, the former will be found to include a somewhat larger number of the very common and much diffused or dominant species. This might have been anticipated; for the

never varying on the same tree, and never found connected by intermediate states. After this discussion, the result of so much labour, he emphatically remarks: "They are mistaken, who repeat that the greater part of our species are clearly limited, and that the doubtful species are in a feeble minority. This seemed to be true, so long as a genus was imperfectly known, and its species were founded upon a few specimens, that is to say, were provisional. Just as we come to know them better, intermediate forms flow in, and doubts as to specific limits augment." He also adds that it is the best known species which present the greater number of spontaneous varieties and sub-varieties. Thus *Quercus robur* has twenty-eight varieties, all of which, excepting six, are clustered round three sub-species, namely *Q. pedunculata*, *sessiliflora* and *pubescens*. The forms which connect these three sub-species are comparatively rare; and, as Asa Gray again remarks, if these connecting forms which are now rare were to become wholly extinct, the three sub-species would hold exactly the same relation to each other as do the four or five provisionally admitted species which closely surround the typical *Quercus robur*. Finally, De Candolle admits that out of the 300 species, which will be enumerated in his *Prodromus* as belonging to the oak family, at least two-thirds are provisional species, that is, are not known strictly to fulfil the definition above given of a true species. It should be added that De Candolle no longer believes that species are immutable creations, but concludes that the derivative theory is the most natural one, "and the most accordant with the known facts in palæontology, geographical botany and zoology, of anatomical structure and classification."

When a young naturalist commences the study of a group of organisms quite unknown to him, he is at first much perplexed in determining what differences to consider as specific and what as varietal; for he knows nothing of the amount and kind of variation to which the group is subject; and this shows, at least, how very generally there is some variation. But if he confine his attention to one class within one country, he will soon make up his mind how to rank most of the doubtful forms. His general tendency will be to make many species, for he will become impressed, just like the pigeon or
poultry
amount
continu...
knowledge of analogical variation in other groups and in other countries by which to correct his first impressions. As he extends the range of his observations, he will meet with more cases of difficulty; for he will encounter a greater number of closely allied forms. But if his observations be widely extended, he will in the end generally be able to make up his own mind; but he will succeed in this at the expense of admitting much variation,—and the truth of this admission will often be disputed by other naturalists. When he comes to study allied forms brought from countries not now continuous, in which case he cannot hope to find intermediate links, he will be compelled to trust almost entirely to analogy, and his difficulties will rise to a climax.

Certainly no clear line of demarcation has as yet been drawn between species and sub-species—that is, the forms which in the opinion of some naturalists come very near to, but do not quite arrive at, the rank of species; or, again, between sub-species and well-marked varieties, or between lesser varieties and individual differences. These differences blend into each other by an insensible series; and a series impresses the mind with the idea of an actual passage.

Hence I look at individual differences, though of small interest to the systematist, as of the highest importance for us, as being the first steps towards such slight varieties as are barely thought worth recording in works on natural history. And I look at varieties which are in any degree more distinct and permanent, as steps towards more strongly marked and permanent varieties; and at the latter, as leading to sub-species, and then to species. The passage from one stage of difference to another may, in many cases, be the simple result of the nature of the organism and of the different physical conditions to which it has long been exposed; but with respect to the more important and adaptive characters, the passage from one stage of difference to another may be safely attributed to the cumulative action of natural selection, hereafter to be explained, and to the effects of the increased use or disuse of parts. A well-marked variety may therefore be called an incipient species; but whether this belief is justifiable must be judged by the weight of the various facts and considerations to be given throughout this work.

It need not be supposed that all varieties or incipient species attain the rank of species. They may become extinct, or they may endure as varieties for very long periods, as has been

species is often exceedingly small. I hav n- deavoured to test this numerically b a ra es, and, as far as m imperfect results go, they confirm the view. I ha e also consulted some sagacious and experienced obser rs, and, after deliberation, th y concur in this   w. In this respect, therefore, th species of the larger gen- era resemble varieties, more than d   th spe- cies of the smaller genera. O th case may be put in another w   and t may be said, that in the larger genera, in which a number of varieties or incipient pecies gre t   than th average are now manufacturing, many of the species alread manufactured still t   certain extent resemble varieties, f   th y diff r from each other by less than the usual am unt of difference.

Moreover th species of th larger g nera are related to each other in th sam mann   as the varieties of an   on species are related to each other. N naturalist pret nds that all the species of a genus are equall distinct from each other the ma generall be divided into sub-genera, or sections,   lesser groups. As Fries has w ll remarked, litt groups of species are general clustered lik sat llites around other species. And what are var ties b t groups of forms, unequall   related to each other and clust red round certain forms—that is, round their parent species. Und ubt edly there is on most important point of dif ference between varieties and pecies namely that the amount of diff rence between varie- ties, hen compared w th each other or with their parent species, is much less than that be- t een the species of th same g nus. B t when   com to discuss th principle, as I call t, of D ergence of Character w   shall see how this ma be explained, and how th lesse diff ences between varieties t nd t increase into the greater differences between species.

There is one oth   point which is worth no- tice. Varieties generall ha e much restricted ranges this stat ment is indeed scarcel more than truism, for if   ariet were found to ha   wider rang than that of ts supposed parent species, their d nominations would be reversed. B t there is reason to beli   that the species which are   ry closel allied to other species, and in so far resemble varieties, often ha   much restricted ranges. For in- stance, Mr H. C. Watson has marked f   m in the w ll-sifted *London Catalogue of Plants* (4th ed tion) 63 plants which are therein ranked as species, but which h considers as so closely allied to other species as to be of d ubtful al e these 63 reputed species range n an   rag o   6.9 of the pro inces into which Mr Watson has di ided Great Britain. N w in this same *C t logue* 53 acknowled ed vari ties are recorded and these range over pro inces wh reas, th spec es to which these vari ties belong range o   14.3 provinces. So that the acknowledged   ri t es hav   n arl the same restri ted   rage range as ha e th closely allied f rms, marked f r m by Mr W tson as doubtf l pecies, but which are al most uni   rsally ranked by British botanists as good and tru   pecies.

Summary

Finall   vari ties cannot be distinguished from species,—except, first, by th disco ry of intermediat linking f rms and, secondl b a certain ind finit amount of diff rence be- tween th m for two forms, if differing v ry little are gen rally ranked as varieties, n t withstanding that th y cannot be closely con- nected b t th amount of diff rence consid   red necessary to gi e to an   two f rms th rank of pec es cannot be defined. In gen ra having more than the   vera   number of pe- cies in an   country th species of these g n ra h   e more than th   verag numbe of varie- t es. In large gen ra the species are apt to be restricted ranges. In all these respects th spe- cies of large g n ra present   trong analogy with vari ties. And w can learly understand these analogies, if species nce exi ted as varie- ties, and thus originated whereas, these anal- gies are utt rly inexplicable if species are ind pendent creations.

W   have also, seen that t is th most flour ishin   o dominant species of the large g nera within ach class which on an   verage yield th greatest   umbe of vari ties and var ties, as w   shall hereafte   see t nd to become con-   rted into new and distinct species. Thus th large   genera tend to become large   and throughout nature th forms of lif   which are now dominant tend to becom   still more d mi- nant b   l ving man   modified and d minant descendants. B t b   t ps h reaft   to be ex plained, the large   genera also t nd to break   p into smaller ge era. And thus, th f rms of lif throu ho t the uni erse becom   divided into groups subordinate to groups.

mere fact of many species of the same genus inhabiting any country shows that there is something in the organic or inorganic conditions of that country favourable to the genus and consequently we might have expected to have found in the larger genera or those including many species a larger proportional number of dominant species But so many causes tend to obscure this result that I am surprised that my tables show even a small majority on the side of the larger genera I will here allude to only two causes of obscurity Fresh water and salt loving plants generally have very wide ranges and are much diffused but this seems to be connected with the nature of the stations inhabited by them and has little or no relation to the size of the genera to which the species belong Again plants low in the scale of organisation are generally much more widely diffused than plants higher in the scale and here again there is no close relation to the size of the genera. The cause of lowly organised plants ranging widely will be discussed in our chapter on Geographical Distribution

From looking at species as only strongly marked and well-defined varieties I was led to anticipate that the species of the larger genera in each country would oftener present varieties than the species of the smaller genera for wherever many closely related species (i e

large trees grow we expect to find saplings Where many species of a genus have been formed through variation circumstances have been favourable for variation and hence we might expect that the circumstances would generally be still favourable to variation On the other hand if we look at each species as a special act of creation there is no apparent reason why more varieties should occur in a group having many species than in one having few

To test the truth of this anticipation I have arranged the plants of twelve countries and the coleopterous insects of two districts into two nearly equal masses the species of the larger genera on one side and those of the smaller genera on the other side and it has invariably proved to be the case that a larger proportion of the species on the side of the larger genera presented varieties than on the side of the smaller genera. Moreover the species of the large genera which present any varieties invariably present a larger average number of varieties than do the species of the small genera Both these results follow when another division is made and when all the least genera, with from only one to four species are altogether excluded from the tables These facts are of plain signification on the view that species are only strongly marked and permanent varieties for wherever many species of the same genus have been formed or where if we may use the expression the manufactory of species has been active we ought generally to find the manufactory still in action more especially as we have every reason to believe the process of manufacturing new species to be a slow one And this certainly holds true if varieties be looked at as incipient species for my tables clearly show as a general rule that wherever many species of a genus have been formed the species of that genus present a number of varieties that is of incipient species beyond the average It is not that all large genera are now varying much and are thus increasing in the number of their species or that no small genera are now varying and increasing for if this had been so it would have been fatal to my theory inasmuch as geology plainly tells us that small genera have in the lapse of time often increased greatly in size and that large genera have often come to their maxima, declined and disappeared All that we want to show is that when many species of a genus have been formed on an average many are still forming and this certainly holds good

Many of the Species included within the Larger Genera resemble Varieties in being very closely but unequally related to each other and in having restricted ranges

is no infallible criterion by which to distinguish species and well marked varieties and when intermediate links have not been found between doubtful forms naturalists are compelled to come to a determination by the amount of difference between them judging by analogy whether or not the amount suffices to raise one or both to the rank of species. Hence the amount of difference is one very important criterion in settling whether two forms should be ranked as species or varieties Now Fries has remarked in regard to plants and Westwood in regard to insects that in large genera the amount of difference between the

The Term Struggle for Existence used in a large sense

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ce m y be now inc easing m re r less rap d ly n numbers all can ot do so f r tl e w rld w ld not hold them

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ar no tl co m est o tl wh l plai f La l l ta, l tl g i l g f rface lm t t tl l n f y ther plant l b trod d f m E l d th e re plants wh l n w ang n Ind a, as I l f D F lco r f m C pe Com n to the H m l ya, wl ch h been impo ted f om Am its d sco y In cl as and dl ss tl co ld be g en ppose th t th f tilty f th an mal plants has b dd ly and tempo rily increased n

CHAPTER III

STRUGGLE FOR EXISTENCE

BEFORE entering on the subject of this chapter I must make a few preliminary remarks to show how the struggle for existence bears on Natural Selection It has been seen in the last chapter that amongst organic beings in a state of nature there is some individual variability indeed I am not aware that this has ever been disputed It is immaterial for us whether a multitude of doubtful forms be called species or sub species or varieties what rank for instance the two or three hundred doubtful forms of British plants are entitled to hold if the existence of any well marked varieties be admitted But the mere existence of individual variability and of some few well marked varieties though necessary as the foundation for the work, helps us but little in understanding how species arise in nature How have all those exquisite adaptations of one part of the organisation to another part and to the conditions of life and of one organic being to another being been perfected? We see these beautiful co adaptations most plainly in the woodpecker and the mistletoe and only a little less plainly in the humblest parasite which clings to the hairs of a quadruped or feathers of a bird in the structure of the beetle which dives through the water in the plumed seed which is wafted by the gentlest breeze in short we see beautiful adaptations everywhere and in every part of the organic world

Again it may be asked how is it that varieties which I have called incipient species become ultimately converted into good and distinct species which in most cases obviously differ from each other far more than do the varieties of the same species? How do those groups of species which constitute what are called distinct genera and which differ from each other more than do the species of the

gle variations however slight and from whatever cause proceeding if they be in any degree profitable to the individuals of a species in their infinitely complex relations to other organic beings and to their physical conditions of life will tend to the preservation of such individuals and will generally be inherited by the offspring The offspring also will thus have a better chance of surviving for of the many individuals of any species which are periodically born but a small number can survive I have called this principle by which each slight variation if useful is preserved by the term Natural Selection in order to mark its relation to man s power of selection But the expression often used by Mr Herbert Spencer of the Survival of the Fittest is more accurate and is sometimes equally convenient. We have seen that man by selection can certainly produce great results and can adapt organic beings to his own use through the accumulation of slight but useful variations given to him by the hand of Nature But Natural Selection as we shall hereafter see is a power incessantly ready for action and is as immeasurably superior to man s feeble efforts as the works of Nature are to those of Art.

We will now discuss in a little more detail the struggle for existence In my future work this subject will be treated as it well deserves at greater length The elder De Candolle and Lyell have largely and philosophically shown that all organic beings are exposed to severe competition In regard to plants no one has treated this subject with more spirit and ability than W Herbert Dean of Manchester evidently the result of his great horticultural knowledge Nothing is easier than to admit in words the truth of the universal struggle for life or more difficult—at least I have found it so—than constantly to bear this conclusion in mind Yet unless it be thoroughly engrained in the mind the whole economy of nature with every fact on distribution rarity abundance extinction and variation will be dimly seen or quite misunderstood We behold the face of nature bright with gladness we often see superabundance of food we do not see or we forget that the birds which are idly singing round us mostly live on insects or seeds and are thus constantly destroying life or we forget how largely these songsters or their eggs or their nestlings are destroyed by birds and beasts of prey we do not always bear in mind that, though food may be now superabundant it is not so at all seasons of each recurring year

f... grown plants thus out of twenty species growing on a little plot of mown turf (three feet by four) nine species perished, from the other species being allowed to grow up freely.

The amount of food for each species of course gives the extreme limit to which each can increase; but very frequently it is not the obtaining food, but the serving as prey to other animals, which determines the average numbers of a species. Thus there seems to be little doubt that the stock of partridges, grouse, and hares on any large estate depends chiefly on the destruction of vermin. If not one head of game were shot during the next twenty years in England, and, at the same time, if no vermin were destroyed, there would, in all probability, be less game than at present, although hundreds of thousands of game animals are now annually shot. On the other hand, in some cases, as with the elephant, none are destroyed by beasts of prey; for even the tiger in India most rarely dares to attack a young elephant protected by its dam.

Climate plays an important part in determining the average number of a species, and periodical seasons of extreme cold or drought seem to be the most effective of all checks. I estimated (chiefly from the greatly reduced numbers of nests in the spring) that the winter of 1854–5 destroyed four-fifths of the birds in my own grounds; and this is a tremendous destruction, when we remember that ten per cent is an extraordinarily severe mortality from epidemics with man. The action of climate seems at first sight to be quite independent of the struggle for existence; but in so far as climate chiefly acts in reducing food, it brings on the most severe struggle between the individuals, whether of the same or of distinct species, which subsist on the same kind of food. Even when climate, for instance extreme cold, acts directly, it will be the least vigorous individuals, or those which have got least food through the advancing winter, which will suffer most. When we travel from south to north, or from a damp region to a dry, we invariably see some species gradually getting rarer and rarer, and finally disappearing; and the change of climate being conspicuous, we are tempted to attribute the whole effect to its direct action. But this is a false view; we forget that each species, even where it most abounds, is constantly suffering enormous destruction at some period of its life, from enemies or from competitors for the same place and food; and if these enemies or competitors be in the least

...red by any slight change of cli...

...we travel southward... ...in numbers, we may feel sure that the cause lies quite as much in other species being favoured, as in this one being hurt. So it is when we travel northward, but in a somewhat lesser degree, for the number of species of all kinds, and therefore of competitors, decreases northwards; hence in going northwards, or in ascending a mountain, we far oftener meet with stunted forms, due to the *directly* injurious action of climate, than we do in proceeding southwards or in descending a mountain. When we reach the arctic regions, or snow-capped summits, or absolute deserts, the struggle for life is almost exclusively with the elements.

That climate acts in main part indirectly by favouring other species, we clearly see in the prodigious number of plants which in our gardens can perfectly well endure our climate, but which never become naturalised, for they cannot compete with our native plants nor

...seems ...

...mals—often ensue; and here we have a limiting check independent of the struggle for life. But even some of these so-called epidemics appear to be due to parasitic worms, which have from some cause, possibly in part through facility of

...prey.

On the other hand, in many cases, a large stock of individuals of the same species, relatively to the numbers of its enemies, is absolutely necessary for its preservation. Thus we can easily raise plenty of corn and rape-seed, &c., in our fields, because the seeds are in great excess compared with the number of birds which feed on them; nor can the birds, though having a super-abundance of food at this one season, increase in number proportionally to the supply of seed, as their numbers are checked during the winter; but any one who has tried, knows how troublesome it is to get seed from a few wheat or other such plants in a garden; I have in this case lost every single seed. This view of the necessity of a large

any sensible degree The obvious explanation is that the conditions of life have been highly favourable an l tl + l

u t r geometrical ratio of increase the result of which never fails to be surprising simply explains their extraordinarily rap l in crease and wide diffusion in their new homes

In a state of nature almost every full grown plant annually produces seed and amongst animals there are very few which do not an nually pair Hence we may confidently assert that all plants and animals are tending to in crease at a geometrical ratio —that all would rapidly stock every station in which they coul l anyhow exist —and that this geometri cal tendency to increase must be checke l by destruction at some period of life Our famili arity with the larger domestic animals tends I think to mi lead us we see no great destruc tion falling on them but we do not keep in min l that thousands are annually slaughtered for food and that in a state of nature an e jual number would have somehow to be disposed of

The only difference between organisms which annually produce eggs or seeds by the thousan l and those which produce extremely few is that the slow breeders would require a few more years to people un ler favourable conditions a wl ole di trict let it be ever so large The condor lays a couple of eggs an l the ostrich a score and yet in the same country the condor may be the more numerous of the two the Fulmar petrel lays but one egg yet it is believed to be the most numerous bird in the worl l One fly deposits hun lreds of eggs and another like the hippobosca a single one but this difference loes not determine how many individuals of the two pecies can be sup ported in a district A large number of eggs is of some importance to tl ose species which de pend on a fluctuating amount of food for it allows them rapidly to increase in number But the real importance of a large number of eggs or seeds is to make up for much destruction at some period of life and this perio l in the great majority of cases is an early one If an animal can in any way protect its own eggs or young a small number may be produced and yet tl e average stock be fully kept up but if many ggs or young are destroyed many mu t be produced or the species will become extinct It would suffice to keep up the f ill number of a tree which lived on an average for a thousand years if a single seed were produced once in a thou and years supposing that this eed were never lestroyed an l coul l be ensured to germinate in a fitting place So that in all cases the average number of any animal or plant depends only indirectly on the number of its eggs or seeds

In looking at Nature it is most necessary to keep the foregoing considerations always in mind—never to forget that every single organ ic being may be said to be striving to the ut most to increase in numbers that each lives by a struggle at some period of its life that heavy destruction inevitably falls either on the young or old luring each generation or at recurrent intervals Lighten any check mitigate the de struction ever so little and the number of the species will almost instantaneously increase to any amount

Nature of the Checks to Increase

The causes which check the natural ten l ency of each species to increase are most obscure Look at the most vigorous species l y as much as it swarms in numbers by so much will it tend to increase still further We know not exactly what the checks are even in a single instance Nor will this surprise any one who reflects how ignorant we are on this head even in regard to mankind although so incompar ably better known than any other animal This subject of the checks to increase has been ably treate l by several authors and I hope in a future work to discuss it at considerable length more e pecially in regar l to the feral animals of South America Here I will make only a few remarks just to recall to the rea ler s mind some of the chief points Eggs or very young animals seem generally to suffer most but this is not invarial ly tl e case With plants there is a vast lestruction of seeds but from some observations which I have made it appears that the seedl ngs suffer most from germin it

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on a piece of ground tl ee f et lor g ar l two v i le dug an l clear d and v l er tl ere coul l be no choking from other plants, I ma ked all the eedlings of ou native v e ls as tl ey ame up and out of 3 7 no less tl an 9. r le stroye l hiefly by slugs and in ects If turf which has lor g been mown and tl e case v oul l be the same with turf closely brow ed by qua l rupeds be let to grow tl e more igorous plants gradually kill tl e less vigorou tl ough

m

balanced, that the face of nature remains for l long periods of time unif rm though assuredly the merest trifle would give th victory to ne organic being er anoth Ne rth less, so profound is our gno ance and so high ur presumption, that w marv l when w hear of th extinction of an rganic being and as w d not see th cause, we in ke catacl m to desolate the world t law on the d ra tion of th f rms f lif

I am tempted t gi e m re in tance showing how plants and animals rem t in the scale of nat re, are bound t g th r b a w b of complex relations. I shall h reafte ha occasion to show that th tic *Lobel f lgens* is r n ted my gard n by insects, and

to remo e their pollen masses and thus to fertilise them. I find from xperim nts that humble-bees are almost ind spensable to th fertilisation of th hea tsease (*V ol tricolor*) for othe bees d not isit this fl w I ha also found that th isits of bees are necessary for th f rtilisation f som kinds of lo f instance 0 head of D t h l (*T fol m*

produced ,, 00 seeds, b t tl sam n mbe of protected heads produced not ingle seed. H mble-bees alo isit red clo e as oth r bees cannot reach th ectar It has been ug gested that m th ma f rtilise th lo ers but I d bt wh the th y could do so in th case of th red lo from tl ir w ght not bei g ffici t to depress th wing petals. Hence w m y inf as highl probabl that, if the whole genus of h mble-bees becam tinct or ry rare in England, th heartsease and red clo w ld becom ry rare or holly disappear Th mbe of humbl bees in any district depend in a gre t measure pon th numbe of fi ld mice, which destroy their combs and ests and Col. Newman, who has long ttended to th hab ts f h mble-bees, believes that more than two-thirds of th m are thus destro ed all r E land N w th mber of mice is largel d pendent, as ry one knows, th mbe of cats and Col. Newman says, Near llages and mall towns I ha e found the nests f humble-bees m re num rous than else here which I ttrib t to the mber of cats that destroy th mice. Hence t is quit cred ble that th presence f a

l large numb rs in a d strict

In th case of very pecies, man checks, actin, t d ff rent periods of life, and d ring diff rent seaso s o ars, probably come into pla ome on check or som few being g n rally th mo t potent b t all w ll concu in d termin g th a erage number r n th e istence of the speci s. In som cases it an be sh wn th t wid ly-different checks act n the same pec es n diff rent districts. Wh n w look t the plants and busl es cloth ing an ntangled bank, w are tempted to attrib te th r proport nal n mbers and kinds to what w call chance But h w false a view is this E y on has heard that wh n an American fore t is cut d wn a ry diff rent getati n prings up but t has been bserved that anci nt Ind an ruins in the south ern United States, which must f merly ha e been leared of trees, now displa th sam bea tiful di ers t and proporti n f kinds as in th surrounding irgin f re t. What a struggle must h e go on during long cen turies between th se eral kinds of trees ach ann ally scatt ring ts seeds by the th usand what war between nsect and insect—between insects, snails, and th animals w th bird and beasts of prey—all tr ng to rease all feeding ach th the trees, th seeds and seedlings, n th ther plants which first lothed the ground and thu checked th growth of th trees! Throw up a handf l of f th rs, and all fall to the ground accordin to d fin t law b t h w simpl is th probl m wh re ach shall fall compared to th t f th action and reacti n of th innum abl plant and animals wh ch ha e d t r mined, in th course of ce turies, the propo tional numbers and kinds of trees n w growing n th ld I dian ruins

Th d pend ncy of one ganic being on an th as f parasit on ts prey h s gen erally between bein rem te in th scal of n ture. This m lik wise som times th case w th those which may be trictly said to trug gl w th ach oth f exist nce as in th case of locusts and grass-feeding q adrupeds. B t th truggl will almost in ariably be most se between th indi d als f th sam pecies, f th y freq ent th sam distri ts, require th sam food and are exposed to th sam dangers. In th ase of var ties of th sam species, th truggle will generally be

stock of the same species for its preservation explains I believe some singular facts in nature such as that of very rare plants being sometimes extremely abundant in the few spots where they do exist and that of some social plants being social that is abounding in individuals even on the extreme verge of their range For in such cases we may believe that a plant could exist only where the conditions of its life were so favourable that many could exist together and thus save the species from utter destruction I should add that the good effects of intercrossing and the ill effects of close interbreeding no doubt come into play in many of these cases but I will not here enlarge on this subject

Complex Relations of all Animals and Plants to each other in the Struggle for Existence

Many cases are on record showing how complex and unexpected are the checks and relations between organic beings which have to struggle together in the same country I will give only a single instance which though a simple one interested me In Staffordshire on the estate of a relation where I had ample means of investigation there was a large and extremely barren heath which had never been touched by the hand of man but several hundred acres of exactly the same nature had been enclosed twenty five years previously and planted with Scotch fir The change in the native vegetation of the planted part of the heath was most remarkable more than is generally seen in passing from one quite different soil to another not only the proportional numbers of the heath plants were wholly changed but twelve species of plant (not counting grasses and carices) flourished in the plantations which could not be found on the heath The effect on the insects must have been still greater for six insectivorous birds were very common in the plantations which were not to be seen on the heath and the heath was frequented by two or three distinct insectivorous birds Here we see how potent has been the effect of the introduction of a single tree nothing whatever else having been done with the exception of the land having been enclosed so that cattle could not enter But how important an element enclosure is I plainly saw near Farnham in Surrey Here there are extensive heaths, with a few clumps of old Scotch firs on the distant hilltops within the last ten years large spaces have been enclosed and self sown firs are now springing up in multitudes so close together that all can not live When I ascertained that these young trees had not been sown or planted I was so much surprised at their numbers that I went to several points of view whence I could examine hundreds of acres of the unenclosed heath and literally I could not see a single Scotch fir except the old planted clumps But on looking closely between the stems of the heath I found a multitude of seedlings and little trees which had been perpetually browsed down by the cattle In one square yard at a point some hundred yards distant from one of the old clumps I counted thirty two little trees and one of them with twenty six rings of growth had during many years tried to raise its head above the stems of the heath and had failed No wonder that, as soon as the land was enclosed it became thickly clothed with vigorously growing young firs Yet the heath was so extremely barren and so extensive that no one would ever have imagined that cattle would have so closely and effectually searched it for food

Here we see that cattle absolutely determine the existence of the Scotch fir but in several parts of the world insects determine the existence of cattle Perhaps Paraguay offers the most curious instance of this for here neither cattle nor horses nor dogs have ever run wild though they swarm southward and northward in a feral state and Azara and Rengger have shown that this is caused by the greater number in Paraguay of a certain fly which lays its eggs in the navels of these animals when first born The increase of these flies numerous as they are must be habitually checked by some means probably by other parasitic insects Hence if certain insectivorous birds were to decrease in Paraguay the parasitic insects would probably increase and this would lessen the number of the navel frequenting flies—then cattle and horses would become feral and this would certainly greatly alter (as indeed I have observed in parts of South America) the vegetation this again would largely affect the insects and this as we have just seen in Staffordshire the insectivorous birds, and so onwards in ever increasing circles of complexity Not that under nature the relations will ever be as simple as this Battle within battle must be continually recurring with varying success and yet in the long run the forces are so nicely

Arctic regions n th b rders of an tte desert, w ll competit on ase Th land m y be extrem ly cold r dry y t the e w ll be competit b tween some f w spec s o be t een the d d l f th sam pec e fo the arm t damp t pots

H ce e can tl t wh n a plant r animal is placed n a n c unt y am g t compet tors, th d t of ts l f w ll g ally be chan ed n an ess t al man e alth b th lim t m y be actly the sa as in ts f m r hom If ts a umb rs are t i rease n l e h me, w l o ld h to odify t in a d ff re t way to what sh ld ha had t d ts nat co t y f h uld h to g t som d an tag r d ff rent set f c pet t r or mies.

It is good thus to try in imaginat n to g ve t y ne pecie an ad antag r an ther P obably n n i gl n ta ce h ld w kn w what t d Th ought to conv inc us of ou i e th m t al r l t s f all o gan i

is t ing to in rea e in a geom t cal o that ach at om pe od f its l f duri some eason of th y a du ing ach gen ra t n o at t als, l as t tr ggle f l fe a d to ff g t d tru t n Wh n w reflect on th s truggl w may co sole sel es th th f ll b l f that the w f natu e s t neces ant, th t n f a f lt, that d th i g ner lly prompt d th t th g rou the healthy and th h ppy s and m lt ply

almost equally severe and we sometimes see the contest soon decided for instance if several varieties of wheat be sown together and the mixed seed be resown some of the varieties which best suit the soil or climate or are naturally the most fertile will beat the others and so yield more seed and will consequently in a few years supplant the other varieties To keep up a mixed stock of even such extremely close varieties as the variously coloured sweet peas they must be each year harvested separately and the seed then mixed in due proportion otherwise the weaker kinds will steadily decrease in number and disappear So again with the varieties of sheep it has been asserted that certain mountain varieties will starve out other mountain varieties so that they cannot be kept together The same result has followed from keeping together different varieties of the medicinal leech It may even be doubted whether the varieties of any of our domestic plants or animals have so exactly the same strength habits and constitution that the original proportions of a mixed stock (crossing being prevented) could be kept up for half a dozen generations if they were allowed to struggle together in the same manner as beings in a state of nature and if the seed or young were not annually preserved in due proportion

Struggle for Life most severe between Individuals and Varieties of the same Species

As the species of the same genus usually have though by no means invariably much similarity in habits and constitution and always in structure the struggle will generally be more severe between them if they come into competition with each other than between the species of distinct genera. We see this in the recent extension over parts of the United States of one species of swallow having caused the decrease of another species The recent increase of the missel thrush in parts of Scotland has caused the decrease of the song thrush How frequently we hear of one species of rat taking the place of another species under the most different climates! In Russia the small Asiatic cockroach has everywhere driven before it its great congener In Australia the imported hive bee is rapidly exterminating the small stingless native bee One species of charlock has been known to supplant another species and so in other cases We can dimly see why the competition should be most severe between allied forms which fill nearly the same place in the economy of nature but probably in no one case could we precisely say why one species has been victorious over another in the great battle of life

A corollary of the highest importance may be deduced from the foregoing remarks namely that the structure of every organic being is related in the most essential yet often hidden manner to that of all the other organic beings, with which it comes into competition for food or residence or from which it has to escape or on which it preys This is obvious in the structure of the teeth and talons of the tiger and in that of the legs and claws of the parasite which clings to the hair on the tiger s body But in the beautifully plumed seed of the dandelion and in the flattened and fringed legs of the water beetle the relation seems at first confined to the elements of air and water Yet the advantage of plumed seeds no doubt stands in the closest relation to the land being already thickly clothed with other plants so that the seeds may be widely distributed and fall on unoccupied ground In the water beetle the structure of its legs so well adapted for diving allows it to compete with other aquatic insects to hunt for its own prey and to escape serving as prey to other animals

The store of nutriment laid up within the seeds of many plants seems at first to have no sort of relation to other plants But from the strong growth of young plants produced from such seeds as peas and beans when sown in the midst of long grass it may be suspected that the chief use of the nutriment in the seed is to favour the growth of the seedlings whilst struggling with other plants growing vigorously all around

Look at a plant in the midst of its range why does it not double or quadruple its numbers? We know that it can perfectly well withstand a little more heat or cold dampness or dryness for elsewhere it ranges into slightly hotter or colder damper or drier districts In this case we can clearly see that if we wish in imagination to give the plant the power of increasing in number we should have to give it some advantage over its competitors or over the animals which prey on it. On the confines of its geographical range a change of constitution with respect to climate would clearly be an advantage to our plant but we have reason to believe that only a few plants or animals range so far that they are destroyed exclusively by the rigour of the climate Not until we reach the extreme confines of life in the

of the inhabitants, independently of the change of climate itself would seriously affect the others. If the country were open on its borders, new forms would certainly immigrate and this would likewise seriously disturb the relations of some of the former inhabitants. Let it be remembered how powerful the influence of a single introduced tree or mammal has been shown to be. But in the case of an island, or of

better filled up, if some of the original inhabitants were in some manner modified; for had the area been open to immigration, these same places would have been seized on by intruders. In such cases, slight modifications, which in any way favoured the individuals of any species, by better adapting them to their altered conditions, would tend to be preserved and natural selection would have free scope for the work of improvement.

We have good reason to believe, as shown in the first chapter, that changes in the conditions of life give a tendency to increased variability and in the foregoing cases the conditions have changed, and this would manifestly be favourable to natural selection, by affording a

tions, it must never be forgotten that more individual differences are included. As man can produce a great result with his domestic animals and plants by adding up in any given direction individual differences, so could natural selection, but far more easily from having incomparably longer time for action. Nor do I believe that any great physical change, as of climate, or any unusual degree of isolation to check immigration, is necessary in order that new and unoccupied places should be left for natural selection to fill up by improving some of the varying inhabitants. For as all the inhabitants of each country are struggling together with nicely balanced forces, extremely slight modifications in the structure or habits of one species would often give it an advantage over others; and still further modifications of the same kind would often still further increase the advantage, as long as the species continued under the same conditions of life and profited by similar means of subsistence and defence. No country can be named in which all the native inhabitants are now so perfectly adapted to each other and to the physical conditions under which they live, that none of them could be still better adapted or improved; for in all countries, the natives have been so far conquered by naturalised productions, that they have allowed some foreigners to take firm possession of the land. And as foreigners have thus in every country beaten some of the natives, we may safely conclude that the natives might have been modified with advantage, so as to have better resisted the intruders.

As man can produce, and certainly has produced, a great result by his methodical and unconscious means of selection, what may not natural selection effect? Man can act only on external and visible characters: Nature, if I may be allowed to personify the natural preservation or survival of the fittest, cares nothing for appearances, except in so far as they are useful to any being. She can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life. Man selects only for his own good; Nature only for that of the being which she tends. Every selected character is fully exercised by her, as is implied by the fact of their selection. Man keeps the natives of many climates in the same country; he seldom exercises each selected character in some peculiar and fitting manner; he feeds a long and a short beaked pigeon on the same food; he does not exercise a long-backed or long-legged quadruped in any peculiar manner; he exposes sheep with long and short wool to the same climate. He does not allow the most vigorous males to struggle for the females. He does not rigidly destroy all inferior animals, but protects during each varying season, as far as lies in his power, all his productions. He often begins his selection by some half-monstrous form, or at least by some modification prominent enough to catch the eye or to be plainly useful to him. Under nature the slightest differences of structure or constitution may well turn the nicely balanced

how poor will be his results, compared with those accumulated by Nature during whole geological periods! Can we wonder, then, that Nature's productions should be far truer in character than man's productions; that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship?

CHAPTER IV

NATURAL SELECTION OR THE SURVIVAL OF THE FITTEST

How will the struggle for existence briefly discussed in the last chapter act in regard to variation? Can the principle of selection which we have seen is so potent in the hands of man apply under nature I think we shall see that it can act most efficiently Let the endless number of slight variations and individual differences occurring in our domestic productions and in a lesser degree in those under nature be borne in mind as well as the strength of the hereditary tendency Under domestication it may be truly said that the whole organisation becomes in some degree plastic But the variability which we almost universally meet with in our domestic productions is not directly produced as Hooker and Asa Gray have well remarked by man he can neither originate varieties nor prevent their occurrence he can preserve and accumulate such as do occur Unintentionally he exposes organic beings to new and changing conditions of life and variability ensues but similar changes of conditions might and do occur under nature Let it also be borne in mind how infinitely complex and close fitting are the

useful to man have undoubtedly occurred that other variations useful in some way to each being in the great and complex battle of life should occur in the course of many successive generations If such do occur can we doubt (remembering that many more individuals are born than can possibly survive) that individuals having any advantage however slight over others would have the best chance of surviving and of procreating their kind? On the other hand we may feel sure that any

the destruction of those which are injurious I have called Natural Selection or the Survival of the Fittest. Variations neither useful nor injurious would not be affected by natural selection and would be left either a fluctuating element, as perhaps we see in certain polymorphic species, or would ultimately become fixed owing to the nature of the organism and the nature of the conditions

Several writers have misapprehended or objected to the term Natural Selection Some have even imagined that natural selection induces variability whereas it implies only the preservation of such variations as arise and are beneficial to the being under its conditions of life No one objects to agriculturists speaking of the potent effects of man s selection and in this case the individual differences given by nature which man for some object selects must of necessity first occur Others have objected that the term selection implies conscious choice in the animals which become modified and it has even been urged that, as plants have no volition natural selection is not applicable to them! In the literal sense of the word no doubt natural selection is a false term but who ever objected to chemists speaking of the elective affinities of the various elements?—and yet an acid cannot strictly be said to elect the base with which it in preference combines It has been said that I speak of natural selection as an active power or Deity but who objects to an author speaking of the attraction of gravity as ruling the movements of the planets? Every one knows what is meant and is implied by such metaphorical expressions and they are almost necessary for brevity So again it is difficult to avoid personifying the word Nature but I mean by Nature only the aggregate action and product of many natural laws and by laws the sequence of events as ascertained by us With a little familiarity such superficial objections will be forgotten

We shall best understand the probable course of natural selection by taking the case of a country undergoing some slight physical change for instance of climate The proportional numbers of its inhabitants will almost immediately undergo a change and some species will probably become extinct We may conclude from what we have seen of the intimate and complex manner in which the inhabitants of each country are bound together that any change in the numerical proportions

an insect to a score f continge ci s, wh lly di. rent from those wh ch co cern tl m ture insect and these modificati ns may affect, thro gh correlation, th tru ture f the adult. So, co rsel modific tions in the d lt m y a ect th truct re f the lar b t all cases natural selectio will nsure that th y hall n t be injurious f if th y w re so the pecies ould become extin t.

N tural selecti ll modify the tru ture of th un in relat n t th pare t, and f th parent in relat to the y ung In social m l t w ll dapt th tru t re f ch in

... it to ...

without gi ing t any ad antag f tl good of another speci and th gh tat ments to h ffect m be f d in w ks of tural

... the ...

cocoo —o th hard t p to th beak f un hatched birds, sed f b aking tl gg It

th th gg wh h had th m t pow rful and hardest beaks, f all w th w ak be ks ld t bly p n l m d l t and m re asil brok h lls m ght b selected, tl th k s f th l ll be g kn n t ary lik n tl tru t

It m be w ll h re t m k th t th all b gs tl must be m ch f t t d truc tion, wl ch an h l tl uffi ce th ourse f nat al selecti n. F in tance a ast mbe f g seed are an ll de tour l, and th se co ld be mod fi l thro gh nat al sel ctio ly f th d som mann wl ich protect d tl m f m tl e m s. Y t many f tl se seed ld perhaps, if not d tro ed l lled f d als b ttt adapt l t tl co d t f l f than any of th se l h l ppe ed t rv e. So again ast mbe f mature an mals and

plants, wh ther or n t they be the best adapt ed to tl r co d t ns, must b annually de troyed by acc dental causes which w uld n t be the l ast d gree mit gated by certain f t wh ch

h avy if th number ... distinct b n t wh lly k pt down by s ch ca ses,— r g n l t th destr t on f ggs r eeds b so gre t that nly a h ndredth a th sandth p rt are d l ped —y t of th se wh h d s e, th b t ad pted individuals s ppo g th t th re i any ari b lity n a f v ur bl d re t w ll t nd to propagate the k d in larg numbers than tl e l ss w ll ad pted If tl n mbers b wh lly k pt d wn by tl e se ju t d cated as w ll often h been th case n t al elect on will be po r l ss ertain b fi l d rect ns b t this is n alid object n to ts ffi n y t th t m and n oth m y s f are f r from ll ng y re so to ppose that many pe es und g mod fi at on and impro e m nt at th same tim in th same area.

Sexu l Selection

I a.m h as pecul rit es oft n appear un d d m t ti n in sex and become h red tarl ttached to th t sex so no d bt t w ll b d n ture. Th it is nd ed pos. bl f th t o se es to b mod fied thro l nat al lect n in lat n t diff t l b t f lif as is som t m th ase f e se t be modified n rel t n to th th ex as comm nly occ s. This leads m to say a f w w rd on what I h alled Se al Select This f m f selecti n d pe d t a tru gl fo ust nce n rel ti to th g nic bein to t l con d ti b t a t gl b tw n th ind d ual f g lly th mal s, fo the posse n f th th se Tl re lt is n t death to tl un ccessf l compet t but f w

pro B t many c ses, t ry d pe d n t so m l n g ral g as n ha pec al w po confi ed to tl m l x. A h nl ss t g p l ss cock w ld h poo l ar e f l g n m ro s ff p Se ual sel ct n, by l y all w g th t to breed m ht rely g d m tabl co ag length to th pur and tre gth to the

It may metaphorically be said that natural selection is daily and hourly scrutinising throughout the world the slightest variations rejecting those that are bad preserving and adding up all that are good silently and insensibly working *whenever and wherever opportunity offers* at the improvement of each organic being in relation to its organic and inorganic conditions of life We see nothing of these slow changes in progress until the hand of time has marked the lapse of ages and then so imperfect is our view into long past geological ages that we see only that the forms of life are now different from what they formerly were

In order that any great amount of modification should be effected in a species a variety when once formed must again perhaps after a long interval of time vary or present individual differences of the same favourable nature as before and these must be again preserved and so onwards step by step Seeing that individual differences of the same kind perpetually recur this can hardly be considered as an unwarrantable assumption But whether it is true we can judge only by seeing how far the hypothesis accords with and explains the general phenomena of nature On the other hand the ordinary belief that the amount of possible variation is a strictly limited quantity is likewise a simple assumption

Although natural selection can act only through and for the good of each being yet characters and structures which we are apt to consider as of very trifling importance may thus be acted on When we see leaf eating insects green and bark feeders mottled grey the alpine ptarmigan white in winter the red grouse the colour of heather we must believe that these tints are of service to these birds and insects in preserving them from danger Grouse if not destroyed at some period of their lives would increase in countless numbers they are known to suffer largely from birds of prey and hawks are guided by eyesight to their prey —so much so that on parts [illegible]

[illegible]

effective in giving the proper colour to each kind of grouse and in keeping that colour when once acquired true and constant Nor ought we to think that the occasional destruction of an animal of any particular colour would produce little effect we should remember how essential it is in a flock of white sheep to destroy a lamb with the faintest trace of black We have seen how the colour of the hogs which feed on the paint root in Virginia determines whether they shall live or die In plants the down on the fruit and the colour of the flesh are considered by botanists as characters of the most trifling importance yet we hear from an excellent horticulturist Downing that in the United States smooth skinned fruits suffer far more from a beetle a Curculio than those with down that purple plums suffer far more from a certain disease than yellow plums whereas another disease attacks yellow fleshed peaches far more than those with other coloured flesh If with all the aids of art these slight differences make a great difference in cultivating the several varieties assuredly in a state of nature where the trees would have to struggle with other trees and with a host of enemies such differences would effectually settle which variety whether a smooth or downy a yellow or purple fleshed fruit should succeed

In looking at many small points of difference between species which as far as our

[illegible]

effect It is also necessary to bear in mind that owing to the law of correlation when one part varies and the variations are accumulated through natural selection other modifications, often of the most unexpected nature will ensue

As we see that those variations which under domestication appear at any particular period of life tend to reappear in the offspring at the same period —*for instance in the shape size* and flavour of the seeds of the many varieties of our culinary and agricultural plants in the caterpillar and cocoon stages of the varieties of the silk worm in the eggs of poultry and in the colour of the down of their chickens in the horns of our sheep and cattle when nearly adult —so in a state of nature natural selection will be enabled to act on and modify organic beings at any age by the accumulation of variations profitable at that age and by their inheritance at a corresponding age If it profit a plant to have its seeds more and more widely disseminated by the wind I can see no greater difficulty in this being effected through natural selection than in the cotton planter increasing and improving by selection the down in the pods on his cotton trees Natural selection may modify and adapt the larva of

dee and the oth m re bulky with sh rter legs, h h more frequ tly att cks tl e sh p-herd flocks.

It sl ld be bserved that in tl bove illustration, I peak f tl e slimme t indi idual wol es, and not cf any s gl tro ly marked ariatio h in bee pre rved In f rm r edi ions of this wo k I som t mes pok as if this latter alt rnati e had f qu tly occ rred I saw the gre t mportance f d dual d ffe nces, and th led m f llv t d scuss th re sults of unconsc selecti by man wh ch d pends tl e preser ati n f all the m re or less al abl d id ls, and n the d truc t f th rst I saw also tl t the prese

I d d t ppreciat how arely gl ar a tions, h th sl ght tro gl marked co ld be perpet ted Th n tl take th case of a pair f animals, prod l their lif tim tw h dred ff pr g f h l from no f d tr t l t an

rations. Tl tr e f tl se rem ks ann t, I think be d p ted If f t ce b rd f som kind co ld proc t food m as ly by ha g ts be k ed and f w re born th ts beak tro gly ed d wh h conseq ty fl rished, n th l ss tl ere uld be a ry poo chance f this m d l al perpetu ting ts k l to tl lus n of the commo f rm b t th re ar l rdly be d lt dg by wl t w see tak g place

the destruct on of a t ll larg r number with the str

It sh certain wh ch differe

o ganisat on be im larly acted o —of wl ch fact um rou nstances could be g ven w th u domest c produ t ons In su h ases, f the vary n nd vidual d d n t act ally transm t to its offspri g its newly-acqu red charact t w uld und ubtedly tran mit to them as l ng as the e i ting ond ti ns re mai ed tl sam a till tro ger t nden y to v y n the same mann Th re can also be l tl t d n y to a y in the

of select n. O nly a third fifth o tenth part f the ind l al may h been thus ffected of wl l fact se eral n t nce co ld

f m ly ranked as a u n m of *Ursa lac ym* I cases f tl s kind if tl ar ti w re f b f rial n ture th g lf m w ld soon b s pplanted by th mod fied fo m thro gh th l f the fittest

T the ffects f i tercros ing in eliminating ariat f all kinds, I h ll h to ecur but t may b h re rem rked th t m t animals and plant k ep to th r prope h m s, and do n t eedl ssly wand b ut we see tl s n w th m grat ry b rds, wh ch almost al ys re t t th sam pot. Conseq tly ach n w ly f med n ty w ld g rally be t first loc l as seems t be th comm u l w th ar t es tat f n t re so th t im larly mod fied l al ls w uld oon ist a m ll bod t g th and w ld ft n breed to-g tl If tl n t were ccessf l its b ttl f lf t w ld l ly pread f m a ce t l d t t, competing w tl d o g tl har d d d al n th argins of an as rel

It m y b w rth wl l to gi e an tl and m re ompl ll trat n f th act on f na-tu l sel ct n C ta n plants ret weet j ce pp re tly f th sak f eliminati g som tl g inj ri from th sap this is ffected f tance, by gl d t th base of th t p l som Legum osæ and t the back f th l a f th comm n la l Th s

wing to strike in the spurred leg in nearly the same manner as does the brutal cockfighter by the careful selection of his best cocks How low in the scale of nature the law of battle de scends I know not male alligators have been described as fighting bellowing and whirling round like Indians in a war-dance for the pos session of the females male salmons have been observed fighting all day long male stag beetles *sometimes bear wounds from the huge* mandibles of other males the males of certain hymenopterous insects have been frequently seen by that inimitable ob erver M Fabre fighting for a particular female who sits by an apparently unconcerned beholder of the strug gle and then retires with the conqueror The war is perhaps severest between the males of polygamous animals and these seem oftenest provided with special weapons Il e males of carnivorous animals are alrea ly well armed thou h to them and to others pecial means of defence may be given through means of sexual selection *as the mane of the lion and the* hooked jaw to the male salmon for the shield may be as important for victory as the sword or spear

Amongst birds the contest is often of a more peaceful character All those who have at tended to the subject believe that there is the severest rivalry between the males of many species *to attract by singing the females* The rock thru h of Guiana birds of paradise and some others congregate and succe sive males

females which standing by as spectators at

has described how a pied peacock was eminent ly attractive to all his hen bird I cannot here enter on the necessary details but if man can in a short time give beauty and an elegant carriage to his bantams according to l is stand ard *of beauty* I can see no goo l reason to doubt that female birds by selecting during thousands of generations the most melod ous or beautiful males *according to their standard* of beauty might produce a marked effect

be explained through the action of sexual selec tion on variations occurring at different ages and transmitted to the males alone or to both sexes *at corresponding ages* but I have not space here to enter on this subject

Thus it is as I believe that when the males and females of any animal have the same gen eral habits of life but differ in structure ol our or ornament such differences have been mainly caused by sexual selection that is, l y individual males having had in successive generations some slight advantage over other males in their weapons means of defence or charms, which they have transmitted to their

arising and becoming attached to the male sex which apparently have not been augmented through selection by man The tuft of hair on the breast of the wild turkey-cock cannot be of any use and it is doubtful whether it can be ornamental in the ey of the female bird — indeed had the tuft appeared under do *mestication it would have been called a mon* strosity

Illustrations of the Action of Natural Selec tion or the Survival of the Fittest

In order to make it clear how as I believe natural selection acts I must beg permission to give one or two imaginary illustrations Let *us take the case of a wolf* which preys on vari ous animals securing some by craft some by strength and some by fleetness and let us suppose that the fleetest prey a deer for in stance had from any change in the country in creased in numbers or that other prey had de creased in numbers during tl at season of tl e year when the wolf was har lest pressed for *food* Under such circumstances the swifte t and slimmest wolves would have the best chance of surviving and so be preserved or se lected —provided always tl at they retained strength to master their pr y at this or some other period of the year wl n they were com pelled to prey on other animals I can see no more reason to loubt that tl is would be tl e result than tl at man shoul l be able to im prove tl e fleetness of l is greyhounds by care ful an l metl od cal selection or by that kind *of unconscious selection* wl ch follows *from* each man trying to keep the l t dogs ith ut any tl ought of modifying the breed I may *add tl at according to* Mr Pierce *there are* two varieties of the wolf inhabiting the Cat skill Mountains in the United States one with a ligl t greyhoun l like form which pursues

bee or other insect, so that certain individuals could be able to obtain their food more quickly than others and thus the communities to which they belonged would flourish and throw off many swarms inheriting the same peculiarities. The tubes of the corolla of the common red and incarnate clovers (*Trifolium pratense* and *incarnatum*) do not on a hasty glance appear to differ in length; yet the hive-bee can easily suck the nectar out of the incarnate clover, but not out of the common red clover, which is visited by humble-bees alone; so that whole fields of red clover offer in vain an abundant supply of precious nectar to the hive-bee. That this nectar is much liked by the hive-bee is certain; for I have repeatedly seen, but only in the autumn, many hive-bees sucking the flowers through holes bitten in the base of the tube by humble-bees. The difference in the length of the corolla in the two kinds of clover, which determines the visits of the hive-bee, must be very trifling; for I have been assured that when red clover has been mown, the flowers of the second crop are somewhat smaller, and that these are visited by many hive-bees. I do not know whether this statement is accurate; nor whether another published statement can be trusted, namely, that the Ligurian bee, which is generally considered a mere variety of the common hive-bee, and which freely crosses with it, is able to reach and suck the nectar of the red clover. Thus, in a country where this kind of clover abounded, it might be a great advantage to the hive-bee to have a slightly longer or differently constructed proboscis. On the other hand, as the fertility of this clover absolutely depends on bees visiting the flowers, if humble-bees were to become rare in any country, it might be a great advantage to the plant to have a shorter or more deeply divided corolla, so that the hive-bees should be enabled to suck its flowers. Thus I can understand how a flower and a bee might slowly become, either simultaneously or one after the other, modified and adapted to each other in the most perfect manner, by the continued preservation of all the individuals which presented slight deviations of structure mutually favourable to each other.

I am well aware that this doctrine of natural selection, exemplified in the above imaginary instances, is open to the same objections which were first urged against Sir Charles Lyell's noble views on "the modern changes of the earth, as illustrative of geology;" but we now seldom hear the agencies which we see still at work, spoken of as trifling or insignificant, when used in explaining the excavation of the deepest valleys or the formation of long lines of inland cliffs. Natural selection acts only by the preservation and accumulation of small inherited modifications, each profitable to the preserved being; and as modern geology has almost banished such views as the excavation of a great valley by a single diluvial wave, so will natural selection banish the belief of the continued creation of new organic beings, or of any great and sudden modification in their structure.

On the Intercrossing of Individuals

I must here introduce a short digression. In the case of animals and plants with separated sexes, it is of course obvious that two individuals must always (with the exception of the curious and not well understood cases of parthenogenesis) unite for each birth; but in the case of hermaphrodites this is far from obvious. Nevertheless there is reason to believe that with all hermaphrodites two individuals, either occasionally or habitually, concur for the reproduction of their kind. This view was

ma... ... ...

All vertebrate animals, all insects, and some other large groups of animals, pair for each birth. Modern research has much diminished the number of supposed hermaphrodites, and of real hermaphrodites a large number pair; that is, two individuals regularly unite for reproduction, which is all that concerns us. But still there are many hermaphrodite animals which certainly do not habitually pair, and a vast majority of plants are hermaphrodites. What reason, it may be asked, is there for supposing in these cases that two individuals ever concur in reproduction? As it is impossible here to enter on details, I must trust to some general considerations alone.

In the first place, I have collected so large a body of facts, and made so many experiments, showing, in accordance with the almost universal belief of breeders, that with animals and plants a cross between different varieties, or between individuals of the same variety but of another strain, gives vigour and fertility to the offspring; and on the other hand, that close interbreeding diminishes vigour and fertility; that these facts alone incline me to be-

juice though small in quantity is greedily sought by insects but their visits do not in any way benefit the plant Now let us suppose that the juice or nectar was excreted from the inside of the flowers of a certain number of plants of any species Insects in seeking the nectar would get dusted with pollen and would often transport it from one flower to another The flowers of two distinct individuals of the same species would thus get crossed and the act of crossing as can be fully proved gives rise to vigorous seedlings which consequently would have the best chance of flourishing and surviving The plants which produced flowers with the largest glands or nectaries excreting most nectar would oftenest be visited by insects and would oftenest be crossed and so in the long run would gain the upper hand and form a local variety The flowers also which had their stamens and pistils placed in relation to the size and habits of the particular insects which visited them so as to favour in any degree the transportal of the pollen would likewise be favoured We might have taken the case of insects visiting flowers for the sake of collecting pollen instead of nectar and as pollen is formed for the sole purpose of fertilisation its destruction appears to be a simple loss to the plant yet if a little pollen were carried at first occasionally and then habitually by the pollen-devouring insects from flower to flower and a cross thus effected although nine tenths of the pollen were destroyed it might still be a great gain to the plant to be thus robbed and the individuals which produced more and more pollen and had larger anthers would be selected

When our plant by the above process long continued had been rendered highly attractive to insects they would unintentionally on their part regularly carry pollen from flower to flower and that they do this effectually I could easily show by many striking facts I will give only one as likewise illustrating one step in the separation of the sexes of plants Some holly trees bear only male flowers which have four stamens producing a rather small quantity of pollen and a rudimentary pistil

tree exactly sixty yards from a male tree I put the stigmas of twenty flowers taken from different branches under the microscope and on all, without exception there were a few pollen grains and on some a profusion As the wind had set for several days from the female to the male tree the pollen could not thus have been carried The weather had been cold and boisterous and therefore not favourable to bees, nevertheless every female flower which I examined had been effectually fertilised by the bees, which had flown from tree to tree in search of nectar But to return to our imaginary case as soon as the plant had been rendered so highly attractive to insects that pollen was regularly carried from flower to flower another process might commence No naturalist doubts the advantage of what has been called the physiological division of labour hence we may believe that it would be advantageous to a plant to produce stamens alone in one flower or on one whole plant and pistils alone in another flower or on another plant In plants under culture and placed under new conditions of life sometimes the male organs and sometimes the female organs become more or less impotent now if we suppose this to occur in ever so slight a degree under nature then as pollen is already carried regularly from flower to flower and as a more complete separation of the sexes of our plant would be advantageous on the principle of the division of labour individuals with this tendency more and more increased would be continually favoured or selected until at last a complete separation of the sexes might be effected It would take up too much space to show the various steps through dimorphism and other means by which the separation of the sexes in plants of various kinds is apparently now in progress but I may add that some of the species of holly in North America are according to Asa Gray in an exactly intermediate condition or as he expresses it are more or less diœciously polygamous

Let us now turn to the nectar feeding insects we may suppose the plant of which we have been slowly increasing the nectar by continued selection to be a common plant and that certain insects depended in main part on its nectar for food I could give many facts showing how anxious bees are to save time for instance their habit of cutting holes and sucking the nectar at the bases of certain flowers which with a very little more trouble they can enter by the mouth Bearing such facts in mind it may be believed that under certain circumstances individual differences in the curvature or length of the proboscis, &c too slight to be appreciated by us might profit a

powen of a distinct variety having a prepotent effect er the flower s wn pollen and that this part of the general law of ood bems, de ved from the intercrossing of distinct individ uals of th same species. When distinct pecie are crossed the case is reversed, for a plant own pollen is almost alwa s prepot nt over foreign pollen b t to this subject we shall f ture ch pter

tree, and at most al from flower to flow r on the same tree and flowers n the sam tree can be considered as distinct individuals only in limited sense. I believe this objection to be valid, b t that nature has largely provided against t b givin t trees a stron tend ncy to bear flow rs with separated sexes. When the sexes are separated, although the male and female flowers may be prod ced on th sam tree, pollen must be regularly carried from flo er to flower and this will gi better chance of pollen being occasi nally carried *from tree to tree* That trees belo ging to all Orders ha their sexes more oft n separated tha ther plants, I find to be t case in this

tan trees are dich gam s, th sam re ult would follow as if th y bore fl w rs w th separated se es. I ha mad these f w remarks n trees simply to call tt tio t th bject.

Turning f br f pace to animals arious terrestrial pecies are h rmaphrod tes, ch as th land mollusca and earth w rm b t these all pair As y t I ha t f d ingl t restrial animal hich can f rtilise tself This remarkable fact, hich off rs so tro g con trast w th terrestrial plants, is t ll bl n the w of an occas nal ross be g indis pensable f win to th nature f th f t lising leme t there are m ans, analog us to the action of insects and of th wind with plants, by which an occasional ross co be effected th terrestrial animals w th t th concurrence of t ndi luals. Of aq tic animals, there are many self fertilizin h ma phrodites but here the currents of w t offer an ob ious means for an occasional cross. As in the case of flowers, I ha as y t failed, after consultation ith one of the highest authorities, namely Professor Huxley to discove a single hermaphrodit animal with th organs of reproduction so perfectly enclosed that access from without, and th occasional influ ence of a distinct individual, can be shown to be physically impossible. Cirripedes long appeared to m to present, and thi point f view a case of great difficulty b t I have been enabled, by a f rtunat chance to pro that two individuals, though both are self f rtilising h rmaphrodites, do som times cross.

It must ha e truck most naturalists as a strange anomal that, both with animals and plants, som species of the sam family and ven f th sam g nus, tho h greeing closely with ach othe n thei wh le rganisa tion, are h rmaphrodites, and som unisexual. B t if in fact, all h rmaphrod tes do occasion ally intercross, the diff rence between them and unise ual species is, as far as functi n is concerned, ve y small.

From these se ral consid rations and from th many special facts which I hav collected b t which I am unable here to gi e, t ppears that w th animals and plants an occasional int rcross between distinct ind viduals is a very eneral, if not uni rsal, law of nature.

Circ msta ces favou able for the production of ne forms th ough Natural Selection

This is an xtremely intricate bject. A gre t am unt f ariab lity und r which t rm indi id al diff rences are alway incl ded w ll

tum f th w k f natural selectio sh does n t grant an ind finite pe od f as all rgan c beings are stri ing to seiz n each place in th eco my f nature if any spec es doe t becom modified and impro ed in a corre spond g d gree w th its competit rs, t will be ext rmin ted. Unles f urabl ari t ns be inh rited by some t least of th ff pring, thing can be effected by natural select n. Th tend ncy to re rsion may oft n check o pre ent th w k b t as this t d n y has n t pre ted man from f rmin by select n num rous d mestic races, why sh uld t prevail ainst natural select n

In th case f methodi cal selecti breed er selects f some definite bject, and if the

lieve that it is a general law of nature that no organic being fertilises itself for a perpetuity of generations but that a cross with another individual is occasionally—perhaps at long intervals of time—indispensable

On the belief that this is a law of nature we can I think understand several large classes of facts such as the following which on any other view are inexplicable Every hybridizer knows how unfavourable exposure to wet is to the fertilisation of a flower yet what a multitude of flowers have their anthers and stigmas *fully* exposed to the weather! If an occasional cross be indispensable notwithstanding that the plant s own anthers and pistil stand so near each other as almost to insure self fertilisation the fullest freedom for the entrance of pollen from another individual will explain the above state of exposure of the organs *Many flowers* on the other hand have their organs of fructification closely enclosed as in the great papilionaceous or pea family but these almost invariably present beautiful and curious adaptations in relation to the visits of insects So necessary are the visits of bees to many papilionaceous flowers that their fertility is greatly *diminished if these visits be prevented* Now it is scarcely possible for insects to fly from flower and flower and not to carry pollen from one to the other to the great good of the plant. Insects act like a camel hair pencil and it is sufficient to ensure fertilisation just to touch with the same brush the anthers *of one flower and then the stigma of another* but it must not be supposed that bees would thus produce a multitude of hybrids between distinct species for if a plant s own pollen and that from another species are placed on the same stigma, the former is so prepotent that it invariably and completely destroys as *has been shown by Gartner* the influence of the foreign pollen

When the stamens of a flower suddenly spring towards the pistil or slowly move one after the other towards it, the contrivance seems adapted *solely* to *ensure self fertilisation* and no doubt it is useful for this end but the agency of insects is often required to cause the stamens to spring forward as Kolreuter has shown to be the case with the barberry and in this very genus, which seems to have a special contrivance for self fertilisation it is well know*n that, if closely* allied forms or varieties are planted near each other it is hardly possible to raise pure seedlings, so largely do they naturally cross In numerous other cases, *far from self fertilisation being* favoured there are special contrivances which effectually prevent the stigma receiving pollen from its own flower as I could show from the works of Sprengel and others as well as from my own observations for instance in *Lobelia fulgens* there is a really beautiful and elaborate contrivance by which *all the infinitely* numerous pollen granules are swept out of the conjoined anthers of each flower before the stigma of that individual flower is ready to receive them and as this flower is never visited at least in my garden by insects it never sets a seed though by placing pollen from one flower on the *stigma of another* I *raise plenty* of seedlings Another species of *Lobelia* which is visited by bees seeds freely in my garden In very many other cases though there is no special mechanical contrivance to prevent the stigma receiving pollen from the same flower yet as Sprengel and more recently Hildebrand and others have *shown* and as I can confirm either the anthers burst before the stigma is ready for fertilisation or the stigma is ready before the pollen of that flower is ready so that these so named dichogamous *plants have in fact* separated *sexes* and *must* habitually be crossed So it is with the reciprocally dimorphic and trimorphic plants previously alluded to How strange are these facts! How strange that the pollen and stigmatic surface of the same flower though placed so

these facts explained on the view of an occasional cross with a distinct individual being advantageous or indispensable!

If several varieties of the cabbage, radish onion and of some other plants be allowed to seed near each other a large majority of the seedlings thus raised turn out as I have found mongrels for instance I raised 233 seedling cabbages from some plants of different varieties growing near each other and of these only *78 were true to their kind* and *some even of* these were not perfectly true Yet the pistil of each cabbage flower is surrounded not only by its own six stamens but by those of the many other flowers on the same plant and the *pollen of each flower readily gets on its own* stigma without insect agency for I have found that plants carefully protected from insects produce the full number of pods. How then comes it that such a vast number of the seedlings are mongrelized *It must arise from the*

ti s, am l Professor Huxley t disco er a s gle h rmapl rod t animal w th th org ns f rr rnd I n so perfectly cl sed that ac

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Ci cumstanc s favourable for tl e production of new forms th ough Natural Selectio i

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In th case f m thod cal selecti a breed er selects f som definite object, and if the

individuals be allowed freely to intercross his work will completely fail But when many men without intending to alter the breed have a nearly common standard of perfection and all try to procure and breed from the best animals improvement surely but slowly follows from this unconscious process of selection notwithstanding that there is no separation of selected individuals Thus it will be under nature for within a confined area with some place in the natural polity not perfectly occupied all the individuals varying in the right direction though in different degrees will tend to be preserved But if the area be large its several districts will almost certainly *present different conditions of life* and then if the same species undergoes modification in different districts the newly formed varieties will intercros on the confines of each But we shall see in the sixth chapter that intermediate varieties inhabiting intermediate districts *will in the long run generally be supplanted by* one of the adjoining varieties Intercrossing will chiefly affect those animals which unite for each birth and wander much and which do not breed at a very quick rate Hence with animals of this nature for instance birds varieties will generally be confined to separated countries and this I find to be the case

on any one pot and might there maintain itself in a body and afterwards pread so that the individuals of the new variety would chiefly cross together On this principle nurserymen always prefer saving seed from a large body of plants as the chance of intercrossing

always eliminate the effects of natural selection for I can bring forward a considerable body of facts showing that within the same area two varieties of the same animal may long remain distinct from haunting different stations from breeding at slightly different seasons or from the individuals of each variety preferring to pair together

Intercrossing plays a very important part in nature by keeping the individuals of the same species or of the same variety true and uniform in character It will obviously thus act far more efficiently with those animals which unite for each birth but as already stated we have reason to believe that occasional intercrosses take place with all animals and plants Even if these take place only at long intervals of time the young thus produced will gain so much in vigour and fertility over the offspring from long continued self fertilisation that they will have a better chance of surviving and propagating their kind and thus in the long run the influence of crosses even at rare intervals will be great With respect to organic beings extremely low in the scale which do not propagate sexually nor conjugate and which *cannot possibly intercross uniformity of character can be retained by them under* the same conditions of life only through the principle of inheritance and through natural selection which will destroy any individual departing from the proper type If the conditions of life change and the form undergoes *modification uniformity of character* can be given to the modified offspring solely by natural selection preserving similar favourable variations

Isolation also is an important element in the modification of species through natural selection In a confined or isolated area, if not very large the organic and inorganic conditions of life will generally be almost uniform so that natural selection will tend to modify all the varying individuals of the same species in the same manner Intercrossing with the inhabitants of the surrounding districts will also be thus prevented Moritz Wagner has lately published an interesting essay on this subject and has shown that the service rendered by isolation in preventing crosses between newly formed varieties is probably greater even than I supposed But from reasons already assigned I can by no means agree with this naturalist that migration and isolation are necessary elements for the formation of new species The importance of isolation is likewise great in preventing after any physical change in the conditions such as of climate elevation of the land &c the immigration of better adapted organisms and thus new places in the natural economy of the district will be left open to be filled up by the modification of the old inhabitants Lastly isolation will give time for a new variety to be improved at a slow rate and this may sometimes be of much importance If however an isolated area be very small either from being surrounded by barriers or from having very

peculiar physical conditions, the total number of the inhabitants will be small and this will retard the production of new species through natural selection, by decreasing the chances of favourable variations arising.

The mere lapse of time by itself does nothing, either *for* or against natural selection. I state this because it has been erroneously asserted that the element of time has been assumed by me to play an all-important part in modifying species, as if all the forms of life

is great, and

ficial variations arising and of their being selected, accumulated, and fixed. It likewise tends to increase the direct action of the physical conditions of life in relation to the constitution of each organism.

If we turn to nature to test the truth of these remarks, and look at any small isolated area, such as an oceanic island, although the number of species inhabiting it is small, as we shall see in our chapter on Geographical Distribution, yet of these species a very large proportion are endemic,—that is, have been produced there and nowhere else in the world. Hence an oceanic island at first sight seems to have been highly favourable for the production of new species. But we may thus deceive ourselves, for to ascertain whether a small isolated area, or a large open area like a continent has been most favourable for the production of new organic forms, we ought to make the comparison within equal times; and this we are incapable of doing.

Although isolation is of great importance in the production of new species, on the whole I am inclined to believe that largeness of area is still more important, especially for the production of species which shall prove capable of enduring for a long period, and of spreading widely. Throughout a great and open area, not only will there be a better chance of favourable variations, arising from the large number of individuals of the same species there supported, but the conditions of life are much more complex from the large number of already existing species; and if some of these many species become modified and improved, others will have to be improved in a corresponding degree, or they will be exterminated. Each new form, also, as soon as it has been much improved, will be able to spread over the open and continuous area, and will thus come into competition with many other forms. Moreover, great areas, though now continuous, will often, owing to former oscillations of level, have existed in a broken condition; so that the good effects of isolation will generally, to a certain extent, have concurred. Finally, I conclude that, although small isolated areas have been in some respects highly favourable for the production of new species, yet that the course of modification will generally have been more rapid on large areas; and what is more important, that the new forms produced on large areas, which already have been victorious over many competitors, will be those that will spread most widely, and will give rise to the greatest number of new varieties and species. They will thus play a more important part in the changing history of the organic world.

In accordance with this view we can, perhaps, understand some facts which will be again alluded to in our chapter on Geographical Distribution; for instance, the fact of the productions of the smaller continent of Australia now yielding before those of the larger Europæo-Asiatic area. Thus, also, it is that continental productions have everywhere become so largely naturalised on islands. On a small island, the race for life will have been less severe, and there will have been less modification and less extermination. Hence we can understand how it is that the flora of Madeira, according to Oswald Heer, resembles to a certain extent the extinct tertiary flora of Europe. All fresh-water basins, taken together, make a small area compared with that of the sea or of the land. Consequently, the competition between fresh-water productions will have been less severe than elsewhere; new forms will have been then more slowly produced, and old forms more slowly exterminated. And it is in fresh-water basins that we find seven genera of Ganoid fishes, remnants of a once preponderant order: and in fresh water we find some of the most anomalous forms now known in the world as the Ornithorhynchus and Lepidosiren, which, like fossils, connect to a certain extent orders at present widely sundered in the natural scale. These anomalous forms may be called living fossils; they have endured to the present day, from having inhabited a confined area, and from having been exposed to less varied, and therefore less severe, competition.

To sum up, as far as the extreme intricacy of the subject permits, the circumstances favourable and unfavourable for the production

of new species through natural selection I conclude that for terrestrial productions a large continental area which has undergone many oscillations of level will have been the most favourable for the production of many new forms of life fitted to endure for a long time and to spread widely Whilst the area existed as a continent the inhabitants will have been numerous in individuals and kinds and will have been subjected to severe competition When converted by subsidence into large separate islands there will still have existed many individuals of the same species on each island intercrossing on the confines of the range of each new species will have been checked after physical changes of any kind immigration will have been prevented so that new places in the polity of each island will have had to be filled up by the modification of the old inhabitants and time will have been allowed for the varieties in each to become well modified and perfected When by renewed elevation the islands were reconverted into a continental area there will again have been very severe competition the most favoured or improved varieties will have been enabled to spread there will have been much extinction of the less improved forms and the relative proportional numbers of the various inhabitants of the reunited continent will again have been changed and again there will have been a fair field for natural selection to improve still further the inhabitants and thus to produce new species

That natural selection generally acts with extreme slowness I fully admit. It can act only when there are places in the natural polity of a district which can be better occupied by the modification of some of its existing inhabitants The occurrence of such places will often depend on physical changes which generally take place very slowly and on the immigration of better adapted forms being prevented As some few of the old inhabitants become modified the mutual relations of others will often be disturbed and this will create new places ready to be filled up by better adapted forms, but all this will take place very slowly Although all the individuals of the same species differ in some slight degree from each other it would often be long before differences of the right nature in various parts of the organisation might occur The result would often be greatly retarded by free intercrossing Many will exclaim that these several causes are amply sufficient to neutralise the power of natural selection I do not believe so. But I do believe that natural selection will generally act very slowly only at long intervals of time and only on a few of the inhabitants of the same region I further believe that these slow intermittent results accord well with what geology tells us of the rate and manner at which the inhabitants of the world have changed

Slow though the process of selection may be if feeble man can do much by artificial selection I can see no limit to the amount of change to the beauty and complexity of the coadaptations between all organic beings one with another and with their physical conditions of life which may have been effected in the long course of time through nature s power of selection that is by the survival of the fittest

Extinction caused by Natural Selection

This subject will be more fully discussed in our chapter on Geology but it must here be alluded to from being intimately connected with natural selection Natural selection acts solely through the preservation of variations in some way advantageous which consequently endure Owing to the high geometrical rate of increase of all organic beings each area is already fully stocked with inhabitants and it follows from this that as the favoured forms increase in number so generally will the less

by few individuals will run a good chance of utter extinction during great fluctuations in the nature of the seasons or from a temporary increase in the number of its enemies But we may go further than this for as new forms are produced unless we admit that specific forms can go on indefinitely increasing in number many old forms must become extinct That the number of specific forms has not indefinitely increased geology plainly tells us and we shall presently attempt to show why it is that the number of species throughout the world has not become immeasurably great

We have seen that the species which are most numerous in individuals have the best

dominant species which offer the greatest number of recorded varieties. Hence, rare species

will be less quickly modified impro ed within any en period they will conseq ntly be beat n in the race f r life by th modified and impro ed d scendants f the comm n species.

From these se ral consid rat n I think it nent ll f llows, that as pec in tl

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suff r most And w ha seen in th hapter the Strugl f r E ist ce th t it is tl e most losel lled f rms,—var t f the sam pec es, and pec es f the sam g n s r of related g ra,—wl from l g nearly the same tru ture co stit t n, and hab ts, gen rall com int th se rest compet t n

kindred, and t nd t ext rmin t th m lv see the sam process f t rmin t am gst ur domesticated prod t ns, thro gh the selectio of impro ed f rm by man Many curi ous instance o ld be g sl w l w quickly n breeds f ttle sheep and th animals, and ri t f fl w rs, tak th place f ld r and inf rio kinds. I Y kshire t historically kn wn th t th an t black cattle re d placed by th l g h rns, and th t these m w pt y by th sl rt h rns (I quot tl w rd f n g ultu al w t) as if by som murd rou pest le ce

D ve ge ce f Cl ar ter

Tl prin pl wl h I l de g ted by this t rm is f l gh mportance and plains, as I belie se ral mpo tant facts. In th first place, ari ties, tro gl m ked nes, thou h h g som h t f tl cl rac ter of spec es—as sl w b th h peless d bts man ase l w to rank tl m—y t certainly d ff far l ss from ach th than d good and distinct peci s. N th less, according t my iew n t es are pec in the proces of format n, are as I l alled them incip t spec es H w tl doe the lesse d ff rence between ari t es becom augmented to th greate diff ce bet een species That this does hab t ally happe w m t inf from most f th inn m rabl species throughout nat re prese ting w ll marked dif rences wh reas ari ties, th supposed prototypes and pare ts of f ture w ll marked

spec es, present slight and ill-d fined d ffer ences. Mere chance as w may call it, m gl t ca se n a ty to d ffe in som ch racter from its p rents, and tl e off prin of th s var ty again to diffe from it parent in tl e very same charact r and in a greater d gree but th s al e would never accou t f r so hab tu l and larg a d gree of differe ce as t l twee tl spec f the same g nus

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H ref rd cattl race and cart h rses, th se eral breeds of p geons, &c. could ne r h been effected by the m re cl ance accu mul t n f simil r variations during many success e ge rat ns. In pract ce a f n er is, f instance, truck by pigeon ha ing a slightly h rt beak anoth fanc r tru k by p geon h in a th r lo g r beak and n the ackn wledged prin ple th t fan r do not and will n t admire a med m tand ard but like tremes, they both go on (as has actually occ red w th th b-breeds of th t mble p geo) choos g and breed ng from b rd w th lo ger and l g beaks r w th sh rte and l o t beaks. Again w may suppose th t at n ea ly period f hi tory th m n f o nat n o d trict required swifte h rses, whilst tl se of an th r requ red strong r and b lk h rses. Th arly differences w uld be ry l ght b t, n th course f time from th co tin ed select n f swift horses in th case and of tro g on in th oth r th diff re ce w ld becom great and w ld b ted as f rming tw ub-breeds. Ultimat ly afte th lapse of ce tu es, th se ub-breed w ld becom con ted into two w ll-e tablished and d tin t breeds. As the d ff re ces becam gre t the inf r an mals with intermediat characters, being th w ft ry tro g w uld not ha e been sed f breeding and w ll thus ha tended to d sappe H re we see in man prod cti ns the act n f what m be called th prin pl f d gence ca ing d f f rences, t first barely ppreciabl t ad ly to increase and th b eeds t di rg in ch ra t r both from each th and from their comm n pare t.

B t h w t m y b asked, can any anal g principl pply in nature I belie t can and doe pply most fficiently (though t was a long time bef re I saw how) from th simpl

circumstance that the more diversified the *descendants from any one species become* in structure constitution and habits by so much will they be better enabled to seize on many and widely diversified places in the polity of nature and so be enabled to increase in numbers

We can clearly discern this in the case of animals with simple habits Take the case of a carnivorous quadruped of which the number that can be supported in any country has long ago arrived at its full average If its natural power of increase be allowed to act it can succeed in increasing (the country not undergoing any change in conditions) only by its varying descendants seizing on places at present *occupied by other animals some of them for* instance being enabled to feed on new kinds of prey either dead *or alive some inhabiting* new stations climbing trees frequenting water and some perhaps becoming less carnivorous The more diversified in habits and structure the descendants of our carnivorous animals *become the more places they will be enabled* to occupy What applies to one animal will apply throughout all time to all animals—that is if they vary—for otherwise natural selection can effect nothing So it will be with *plants It has been experimentally proved* that if a plot of ground be sown with one species of grass and a similar plot be sown with several distinct genera of grasses a greater number of plants and a greater weight *of dry herbage can be raised* in the latter than in the former case The same has been found to hold good when one variety and several mixed varieties of wheat have been sown on equal spaces of ground Hence if any one species *of grass were to go on varying* and the varieties were continually selected which differed from each other in the same manner though in a very slight degree as do the distinct species and genera of grasses a greater number of individual plants of this species, including its modified descendants would succeed in living on the same piece of ground And we know that each species and each variety of grass is annually sowing almost countless seeds and is thus striving as it may be said to the utmost to increase in number Consequently in the course of many thousand generations the most *distinct varieties of any* one species of grass would have the best chance of succeeding and of increasing in numbers and thus of supplanting the less distinct varieties and varieties, when rendered very distinct from each other take the rank of species

The truth of the principle that the greatest amount of life can be supported by great diversification of structure is seen under many natural circumstances In an extremely small area especially if freely open to immigration and where the contest between individual and individual must be very severe we always find great diversity in its inhabitants For instance I found that a piece of turf three feet by four in size which had been exposed for many years to exactly the same conditions *supported twenty species of plants* and these belonged to eighteen genera and to eight orders which shows how much these *plants differed from each other* So it is with the plants and insects on small and uniform islets *also in small ponds of fresh water* Farmers find that they can raise most food by a rotation of plants belonging to the most different orders nature follows what may be called a simultaneous rotation Most of the *animals and plants which live close round any* small piece of ground could live on it (supposing its nature not to be in any way peculiar) and may be said to be striving to the utmost to live there but it is seen that where they come into the closest competition the advantages of diversification of structure with the accompanying differences of habit and constitution determine that the inhabitants which thus jostle each other most closely shall as a general rule belong to what we call different genera and orders

The same principle is seen in the naturalisation of plants through man s agency in foreign lands It might have been expected that the plants which would succeed in becoming naturalised in any land would generally have been closely allied to the indigenes for these are commonly looked at as specially created and adapted for their own country It might also perhaps have been expected that naturalised plants would have belonged to a few groups

in his great and admirable work that floras gain by naturalisation proportionally with the number of the native genera and species *far more in new genera than in new species* To give a single instance in the last edition of Dr Asa Gray s *Manual of the Flora of the Northern United States* 260 naturalized plants are enumerated and these belong to 162

genera. W thus see that these naturalised pants are of hgal di rsified nature Th y differ moreo er t larre t nt, from the mageres, for out of the 16 naturalised gen ra, no less than 100 gen ra are not th re ind ous, and thus lare proportional add tion is made to the genera n w livin m th United States.

B considering the nature of the plants o animals which ha in an country tru led successfu th th ind g nes and ha there become naturalised, w ma gain som crud idea in hat manner som f the nat would ha e to be modified, in rd to g in an advantage er their compatriots and we ma t least inf that di ersificat on f true ture, amounting to new gen ri diff rences, would be profitable to th m

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Milne Edwards. N ph iologist d bts that a stomach adapted to d gest g tabl m tte alone, or flesh alo draw mo t n triment from these substances. So in th general economy of an land, th more wid l and perfect l the animals and plants are d rsified f different hab ts of li so will greate umbe of indi iduals be capal le f there supporting themsel es. A set of animals, with th ir organisation b t little d rsified, could hardl compete w th set m re perfectl di rsified in structure It ma be d bted, for in tance hethe the Australian marsupials, which are d ided into group differing b t littl from each the and feebl representing, as M Waterhouse and oth rs ha remarked, our carni orous, ruminant, and rod t mammals, could successful compet w th these w ll-de ped rders. In th Au tralian mammals, see the process of di rsificatio in an earl and incomplete ta of dev lopment.

The Probabl Effects f th e Ac n of Natu al S l ction thro h D ergence of Cha acter nd Ext ct the De end nts f C mmo t cesto

After the foregoing iscussion, which has been much compressed, w ma assum that the modified escendant of an on pecies ll succeed so much the bette as th be come more d rsified tructure and are thus enabled t encroach on places occupied by oth beings. Now l t us see h w this prin iple of ben fit being d ri ed from d rgence of character combined with the principles of natural selection and of extinction, tends to act.

Th accompanying diagram will aid us in und rstanding this rath perpl xin bject Let A to L represent th species of a g nus lar in ts wn country thes species are p-posed to resembl each th r in unequal d grees, as is so ge rally th case in nature, and as is represented in th diagram by the l tt rs tandi g t unequal distances. I ha said a larg g n s, because as we saw in the second chapt an a rage more species vary in lar gen ra than in mall genera and the varyin spec s f the large genera present a greate numbe f vari ties. We have, also, seen that th species, which are the common est and th most wid ly diffused, vary m re than d th rare and restricted species. Let (A) be a common, wid l -diffused and vary in speci s, belongin to a g nus lar in its wn country Th branchin and d rgin d tted lines of unequal l ngths proceedin from (A) ma represe t ts arying off-pring. Th riations are supposed t be xtrem ly slight, b t of th most d rsified nature the are t supposed all to ppear imultaneously b t often aft l ng int rvals of time no are

lected. And here th importance of the prin ciple of ben fit deri ed from di erg nce f character comes in f this will gen rally le d to the most diff reat o di rgent riation (represented b th o t d tted line) bein pre-erved and accumulated by natural selec tion. When a d tted lin reaches o of th horizo tal lines, and is there m ked by mall umbered l tter a sufficient amount of aria tion is supposed t ha been accumulated to f rm t into fa rl w ll m ked variety such as w uld be thought w rth of record in st matic wo k.

Th int rvals between th horizontal lines in th diagram m represent each a thousand m re gen rations. Afte a thousand gen ra tions, spec es (A) is supposed to ha pro-d ced tw fairl well-marked varieties, name-ly and m These two arieties will gen rally stil be posed to th sam conditions which mad their parents ariable and th tend ncy to ariabilit is in itself h reditary conse-q ently the will likewise tend to ary and

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commonly in nearly the same mann r as did their parents. Moreo these two varieties, being only slightly modified forms, will tend to inherit those ad antages which made th ir parent (A) more numerous than most of the other inhabitants of the same country they will also partake of those more general advantages which mad th genus to which the parent-species belonged, a large genus in its own country And all these circumstances are favourable to the production of new varieties.

If, then, these two arieties be variable, the most divergent of their variations will generally be preserved d ring the next thousand generations. And after this interval, variety is supposed in the diagram to ha e produced variety which will, owing to th principl of divergence, differ more from (A) than did variet Variet m is supposed to ha produced tw arieties, namel m and s diff ring from each other and more considerabl from their common parent (A) We may con tinue the process by similar steps f any length of tim som of the vari ties, after each thousand gen rations, producing only a single variet b t in more and more modified condition, some producing two r three varieties, and som failing to produce any. Thus the arieties or modified descendants of the common parent (A) will generally go on increasing in number and d rging in charac ter In the diagram the process is represented up to the ten thousandth generation, and under condensed and simplified f rm p to the fourteen-thousandth generation.

B t I must here remark that I do not suppose that the process goes on so regularly as is represented in th diagram, though in t self made somewhat irregular nor that t goes on continuousl t is far more probable that each form remains for long periods unaltered, and then again und rgoes modification. Nor do I suppose that the most divergent varieties are invariably preserved medi m f rm may often long endure, and may or may not produce more than on modified descendant for natural selection will alw act according to the nature of the places which are either unoccupied or not perfectly occupied b other beings and this will depend on infinit ly complex relations. B t as general rule th more diversified in structure th descendants from any one species can be rendered, the more places the ill be enabled to seize on, and the more their modified progeny will increase. In our diagram the line of succession is broken at regular intervals by small numbered lett rs marking th successive forms which have become sufficiently distinct to be recorded as varieties. B t these breaks are imaginary and might hav been inserted anywhere, after inter vals long enough to allow th accumulation of a consid rable amount of di ergent variation.

As all the modified descendants from a com mon and widely-diffused species, belo ging to a large gen s, will tend to partake of th same ad an ful in l in nu...

thus is represented in the diagram by the several divergent branches proceeding from (A) The modified offspring from th later and more highly improved branches in th lines of descent, will, t is probable often take the place of, and so destroy the earlier and less impro ed branches this is represented in the diagram by som of the lower branches not reaching to th upper horizontal lines. In some cases no doubt th process of modification will be confined to a single line of descent and the numbe of modified descendants will not be increased although th amount of diverg ent modification may have been augmented. This case would be represented in the diagram, if all the lines proceeding from (A) were removed, excepting that from a to a^{10} In the sam way the English race-horse and English pointer ha e pparently both gone on slowly d rging in characte from their original stocks, without the having given off any fresh branches or races.

After ten thousand gen rations, species (A) is supposed to ha produced three forms, a^{10} f^{10} and m^{10} which, from having diverged in character during the successive generations, will have com to differ largely but perhaps unequally from each other and from their common parent. If w suppose the amount of change between each horizontal line in our diagram to be excessively mall, these three forms may still be only well-marked varieties b t w have only to suppose the teps in th process of modification to be more num rous or greater in amount, to convert these three forms into well-defined or at least into d ubtful species. Thus the diagram illustrates th teps by which th mall differences distinguishing varieties are increased into the larg differences distinguishing species. By continuing the sam process f a great r numbe of generations (as shown in the diagram in a cond nsed and simplified manner)

we get eight pecies marked by the letters be tween a^{14} and m^{14} all descended from (A) Thus as I believe *species are multiplied and* genera are formed

In a large genus it is probable that more than one species would vary In the diagram I have assumed that a second pecies (I) has produced by analogous steps after ten thou sand generations either two well marked varieties (w^{10} and z^{10}) or two species according to the amount of change supposed to be represented between the horizontal lines After fourteen thousand generations six new pecies marked by the letters n^{14} to z^{14} are supposed to have been produced In any genus the species which are already very different in *character from each other will generally tend* to produce the greatest number of modified descendants for these will have the best chance of seizing on new and widely different places in the polity of nature hence in the dia gram I have chosen the extreme species (A) and the nearly extreme species (I) as those which have largely varied and have given rise to new varieties and species The other nine species (marked by capital letters) of our

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played an important part As in each fully stocked country natural selection necessarily acts by the selected form having some advan tage in the struggle for life over other forms, there will be a constant tendency in the im proved descendants of any one species to sup plant and exterminate in each stage of descent their predecessors and their original progen

lated to each other in habits constitution and structure Hence all the intermediate forms between the earlier and later states that is between the less and more improved states of the same species, as well as the original parent pecies itself will generally tend to become extinct. So it probably will be with many whole collateral lines of descent which will be conquered by later and improved lines If however the modified off pring of a species get into some distinct country or become quickly adapted to some quite new station in which off pring and progenitor do not come into competition both may continue to exist

If then our diagram be assumed to repre sent a considerable amount of modification species (A) and all the earlier varieties will have become extinct being replaced by eight new pecies (a^{14} to m^{14}) and pecies (I) will be replaced by six (n^{14} to z^{14}) new pecies

But we may go further than this The origi nal species of our genus were supposed to resemble each other in unequal degrees, as is so generally the case in nature pecie (A) being more nearly related to B C and D than to the other species and pecies (I) more to G H K L than to the others These two species (A) and (I) were also supposed to be very common and widely diffused pecies, so that they must originally have had some ad vantage over most of the other specie of the genus Their modified descendants, fourteen in number at the fourteen thousandth genera tion will probably have inherited some of the same advantages they have also been modi fied and improved in a diversified manner at each stage of descent so as to have become adapted to many related places in the natural economy of their country It seems therefore extremely probable that they will have taken the places of and thus exterminated not only their parents (A) and (I) but likewise some of the original pecies which were most nearly related to their parents. Hence very few of the original species will have transmitted off spring to the fourteen thousandth generation We may suppose that only one (F) of the two pecies (L and F) which were least closely related to the other nine original pecie has transmitted descendants to this late stage of descent.

The new species in our diagram descended from the original eleven pecies will now be fifteen in number Owing to the divergent tendency of natural selection the extreme amount of difference in character between species a^{14} and will be much greater than that between the most distinct of the original eleven pecies The new pecies moreover will be allied to each other in a widely different manner Of the eight descendants from (A) the three marked a q p will be nearly

distinct from the three first named species and lastly o e and m will be nearly re lated one to the other but, from having

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di rged t the first commencem t f the process of modificati n, will be w d ly d ff rent from the oth fi pec es, and m constit t sub-gen distı t g us.

Th ix d sce dants from (I) w ll f rm two sub-g ra r g n ra. B t as th riginal pecies (I) diff red larg ly from (A) tand g early t th treme d f the ori inal gen s, the six d sce dants from (I) will owın to inheritance alo d ff cons derabl from the ıght d sce dants from (A) th tw gro ps, m reo e are supposed t h g di rı g diff re t directions. Th int r m l t spec es, also (and this ıs ry m

the artl s eru t ın luding extinct remains wh n w com to our ch pte on

and w can nd rstand this fact to ın

t n t pec s h ed at various remote poc! wh n th branch g line of desce t had d rged l ss.

I see n reason t l m t th process f mod ficat on as n w xplained to th f rm t n of g ra al ll ın the d agram w ppose th amo nt f chan represented b h cce ro p f d rı g d tted li s t be g mark

g ra, as d ti t sub-f mıl s

Thus t ıs, as I bel e th t tw m re g ra are prod ced b d sce t w th modifi cation, from tw m re pec s f tl sam g us. And th tw n re pare t pec are supposed t b d scended from som n pe- ıe of an arli g s. In d ag am th ıs ındı ted by th brok li s, be tl th p tal l tt rs, co gı g ın b-bra h d wn ards toward l point th point represe t a peci s, th pposed prog t f se al w b-g ra and g a.

It ıs rth whil t reflect f m m t n th haract f th w pec F wl h pposed t t h d rged m h ın l r act b t t ha ret ed th f rm f (F) th nalt red lt red ly l ght l ree I tl ıs case ts affinit t th th f rt e w pec ll be f curı and re t t re B ıng desce ded from form hicl tood bet een th pare t pec (A) and (I) w pposed to be tın t and nkn w t ll be som d gree t rm diat laract bet ee th t gro p d scend l from th se t pec s. B t as th se t gro ps h l gı g harac t from th t pe f th pare ts, th n w speci (F) ll t be d rectl t rmed t bet een tl m b t rath bet ee t pes f th tw gr p an l rv t alı t w ll b able t all l ase bef re h m d

I th diagram each l rızo tal lın has hith rt bee pposed t represe t th u sand ge ratio s, b t ach m y represent a milio or more g ratio t may also represent sectio f tl ccessı trata f

d rs, ccordın to th mount f d gent mod fic ti supposed t be represented ın th d gram And th tw n w f mil s, o ord rs, re d sce ded from two pec s f th al g nus, and th se are pposed to b d sce ded from som till m re an nt d unkn n f m.

W ha seen th t ın ach country ıt the pec s b l gı g t th l rg r g n ra h ch oft est present n ti ın p nt spec Thus, deed m ght h been xpected f as n t al selecti n acts thro gh e f rm h g som ad antag e th f rm ın truggl f xıst nce t w ll cu fly t n th se which already h som ad antage and th larg ness f any gro p sh w th t t peci l ınh rıted from comm n ances- som ad antag ın comm n. H ce th trugl f th prod ti n of n w and modı fied descendants will mainl b between th larg gro p which are all tryı g to incre n mbe O larg group w ll l ly co ı an th larg gro p red ce ts numbers, and th l sse ts hance of f th arı ti n and ımpro m nt. W thin th sam l rg gro p tl lat and m re b gl ly pe fected l gro ps, from branch g t and seizıng n m y ew place th pol ty f Nature will constantl t d t supplant and destroy the arli and l ss ımpro ed sub-gro ps. Small and brok n gro ps and sub-gro ps will finally

disappear Looking to the future we can predict that the groups of organic beings which are now large and triumphant and which are least broken up that is which have as yet suffered least extinction will for a long period continue to increase But which groups will ultimately prevail no man can predict for we know that many groups formerly most extensively developed have now become extinct Looking still more remotely to the future we may predict that owing to the continued and steady increase of the larger groups a multitude of smaller groups will become utterly extinct and leave no modified descendants and consequently that of the species living at any one period extremely few will transmit descendants to a remote futurity I shall have to return to this subject in the chapter on Classification but I may add that as according to this view extremely few of the more ancient species have transmitted descendants to the present day and as all the descendants of the same species form a class we can understand how it is that there exist so few classes in each main division of the animal and vegetable kingdoms Although few of the most ancient species have left modified descendants yet at remote geological periods the earth may have been almost as well peopled with species of many genera, families orders and classes as at the present time

On the Degree to which Organisation tends to advance

Natural Selection acts exclusively by the preservation and accumulation of variations which are beneficial under the organic and inorganic conditions to which each creature is exposed at all periods of life The ultimate result is that each creature tends to become more and more improved in relation to its conditions This improvement inevitably leads to the gradual advancement of the organisation of the greater number of living beings

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the vertebrata the degree of intellect and an approach in structure to man clearly come into play It might be thought that the amount of change which the various parts and organs pass through in their development from the embryo to maturity would suffice as a standard of comparison but there are cases as with certain parasitic crustaceans, in which several parts of the structure become less perfect so that the mature animal cannot be called higher than its larva Von Baer s standard seems the most widely applicable and the best, namely the amount of differentiation of the parts of the same organic being in the adult state as I should be inclined to add and their specialisation for different functions or as Milne Edwards would express it the completeness of the division of physiological labour But we shall see how obscure this subject is if we look for instance to fishes amongst which some naturalists rank those as highest which like the sharks approach nearest to amphibians whilst other naturalists rank the common bony or teleostean fishes as the highest inasmuch as they are most strictly fish like and differ most from the other vertebrate classes We see still more plainly the obscurity of the subject by turning to plants amongst which the standard of intellect is of course quite excluded and here some botanists rank those plants as highest which have every organ as sepals petals stamens and pistils fully developed in each flower whereas other botanists probably with more truth look at the plants which have their several organs much modified and reduced in number as the highest

If we take as the standard of high organisation the amount of differentiation and specialisation of the several organs in each being when adult (and this will include the advancement of the brain for intellectual purposes) natural selection clearly leads towards this standard for all physiologists admit that the specialisation of organs inasmuch as in this state they perform their functions better is an advantage to each being and hence the accumulation of variations tending towards specialisation is within the scope of natural selection On the other hand we can see bearing in mind that all organic beings are striving to increase at a high ratio and to seize on every unoccupied or less well occupied place in the economy of nature that it is quite possible for natural selection gradually to fit a being to a situation in which several organs would be superfluous or useless in such cases there would be retrogression in the scale of organisation Whether organisation on the whole has actually advanced from the remotest geological periods to the present day will be more conveniently discussed in our chapter on Geological Succession

But it may be objected that if all organic beings thus tend to rise in the scale how is it

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planted and ext rmin ted th l w Lan rck, ho belie ed in an nnat and in vitabl tend ncy t ard perfection all rgan beings, seems t l f lt th difficult so strong that he was led t ppose that n w and simpl f rms re co tinually being produced b spo taneou g n ration Sc e ce has not as y t pro ed tl truth of this beli f l t th f t re m re eal On ur

sarl includ pr gressi d l pm t—t nly tak ta of such ari tio as arise and are be ficial t ach re t re nder ts comple relat ns of life And it may be asked hat ad tag far as w can see ould t be to an inf sorian an m lcul —t an intestinal rm—o t an artl w rm to be highl ganised If t w re n ad antag these f rms would be left, by nat ral selecti n, unimpro ed b t l ttl mpro ed, and m lt remain for ind finit ag t th ir prese t lo l condi tio And geolog t lls that som of the lowest forms, as th nf sori and rhizopods, ha remain d f an rm period in ari tl prese t t t B t to suppose that most f tl many tin low f m ha ot th l t ad ancei si ce the first da n f l f would be extrem ly rasl for rs t ral t wl l as l sected som of th bei g low ra ked rs lo th sc l m t ha bee truck w th tl really wondro and bea t f l rganisat n.

N arl th sam remarks are plic ble f look t the d f rent grad of org nisati n thi tl sam gre t gro p f in tance in the rt brata, t the co-exi t nce f m m mal and fish—am t mammalia, t the co- t nce of man and tl rn tho hynch us—mon, t fishe to the co-exist nce of tl shark and th lancelet (Am pl) wh h latter fish in the extreme simplicit of t truct re pproaches the in rtebrat classes. B t mammals a f fish hardly com into com petition with each othe th ad ancement f the hole class of mammals, o of certain members in this las to tl highest grad ould not lead to their taking the place of fishes. Physiol gists b lie that th brain must be bathed by warm blood to be l ighl acti e and this req re aerial re p ratio so th t warm blooded mammal when nhabitin g the w t l e und r a disad antag n ha ing t come co tin ally t th urface to bre th With fishes, m mber f the shark famil would ot te d t pplant tl lancelet f r tl lancel t, as I hea from Fritz Muller has as sol companion and comp t t on tl e l ar ren sand sl re f South Braz l, an an mal us ann l d Th three lowest l rs f mammals, nam ly mars pials, ed ntata, and rodents, co-exi t in South America in the sam reg n w th numero s m nk s, and probably y t r f re l ttl w tl ach oth Alth gh ganisa t n, on th whol m ha ad nced and be t ll ad ancing tl ro gho t the w ld y t th scal will always prese t many d gree of per fect f th h gl ad ancement of ce tain wh le cl ss s, r of certa m mb f e ch lass, doe n t at all nece sarl l ad to the exti t on of those group w th which th y d n t nt nt cl se compet t In som cases, n w h ll l reaft see l wl ganised f rms

se re competiti n and wh re tl eir scanty n mbers ha ret rded the chance f f v ur bl ar ti ns arising.

Finall I belie that many lowly rganised f rms n st thro gh t th w ld from ari us causes. In some case ari ti ns in l ndual luff rence f f urabl nature ma ha risen f natural select n to act n and ccumulate In n ase probably has time fficed f th utm t poss bl am t f d l pm t. In som few cases th re has been what w mu t call retro ress n f organisat n. B t tl mai cause l n the

rgani beings, we ma b l e presented tl mplest t ture h t has bee asked co l th first t p the ad ancem nt l ff re t ti l part ha arise M Herbert Spe cer ld prol abl answ that, as soon as si pl unicellular rganism cam by growth o il t be compo nded f sev eral cells, becam ttach d to any s pport ing surface, l law that hom log us units of any rd become d ff re tiated in proportion as their relations to incid t f rces become

different would come into action. But as we have no facts to guide us, speculation on the subject is almost useless. It is, however, an *error to suppose that there would be no struggle for existence*, and, consequently, no natural selection, until many forms had been produced: variations in a single species inhabiting an isolated station might be beneficial, and thus the whole mass of individuals might be modified, or two distinct forms might arise. But, *as I remarked towards the close of the* Introduction, no one ought to feel surprise at much remaining as yet unexplained on the origin of species, if we make due allowance for our profound ignorance on the mutual relations of the inhabitants of the world at the present time, and still more so during past ages.

Convergence of Character

Mr. H. C. Watson thinks that I have overrated the importance of divergence of character (in which, however, he apparently believes), and that convergence, as it may be called, has likewise played a part. If two species, belonging to two distinct though allied genera, had both produced a large number of new and divergent forms, it is conceivable that these might approach each other so closely that they would have all to be classed under the same

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bute to convergence a close and general similarity of structure in the modified descendants *of widely distinct forms. The shape of a crystal* is determined solely by the molecular forces, and it is not surprising that dissimilar substances should sometimes assume the same form; but with organic beings we should bear in mind that the form of each depends on an infinitude of complex relations, namely on the variations which have arisen, these being due to causes far too intricate to be followed out,—on the nature of the variations which have been preserved or selected, and this depends on the surrounding physical *conditions*, and in a still higher degree on the surrounding organisms with which each being has come into competition,—and lastly, on inheritance (in itself a fluctuating element) from innumerable progenitors, all of which have had their forms determined through equally complex *relations*. It is incredible that the descendants of two organisms, which had originally differed in a marked manner, should ever afterwards converge so closely as to lead to a near approach to identity throughout their whole organisation. If this had occurred, we should meet with the same form, independently of genetic connection, recurring in widely separated geological formations; and the balance of evidence is opposed to any such an admission.

Mr. Watson has also objected that the continued action of natural selection, together with divergence of character, would tend to make *an indefinite* number of specific forms. As far as mere inorganic conditions are concerned, it seems probable that a sufficient number of species would soon become adapted to all considerable diversities of heat, moisture, &c.; but I fully admit that the mutual relations of organic beings are more important; *and as the number of species in any country* goes on increasing, the organic conditions of life must become more and more complex. Consequently there seems at first sight no limit to the amount of profitable diversification of structure, and therefore no limit to the number of species which might be produced. We do not know that even the most prolific area is fully stocked with specific forms: at the Cape of Good Hope and in Australia, which support such an astonishing number of species, many European plants have become naturalised. But geology shows us, that from an early part of the tertiary period the number of species of shells, and that from the middle part of this same period the number of mammals, has not greatly or at all increased. What then checks an indefinite increase in the number of *species? The amount of life (I do not* mean the number of specific forms) supported on an area must have a limit, depending so largely as it does on physical conditions; therefore, if an area be inhabited by very many species, each or nearly each species will be represented by few individuals; and such species will be liable to extermination from accidental fluctuations in the nature of the seasons or in the number of their enemies. The process of extermination in such cases *would be rapid, whereas the production of* new species must always be slow. Imagine the extreme case of as many species as individuals in England, and the first severe winter or very dry summer would exterminate thousands on thousands of species. Rare species, and each species will become rare if the number of species in any country becomes indefinitely increased, will, on the principle often explained, present within a given period few favourable

variations conseq tly the process f g birth t w specifi f rm wo ld th u be re tarded Wh any pec s becom ry r re lose interbreeding w ll h lp t xt rminate t a th h th ught that th s com s into play in acco t g f the detern at on of the

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consequ ntly in m st cases to what mu t be dva ce in rganisat n N r

t b g h t d at corre po d g ages c n mod fy the gg seed r young as asily as th ad lt Am g t many animals, sexual s l c t n w ll h v giv n ts aid t rdinary sel t by ass ring to th m st gorou and be t ad pted m l s th great st numbe of off Sexu l lect n w ll lso gi ch ac

Wh th n t l select n has really thu acted n dapting th r s f rms f lif t the se e l co d t s and stat o must b judged by th g e l t a d balan e f dence g n in th foll wing chapter But w h e l eady seen h w t ta ls extinct n a d h w l g ly t ct n has acted in the w ll s l st y geology plainly declare N t r l lect als l ds to d v rg ce f ch act f th more gan c be g d ge in tru ture hab ts nd nstitut o by so

Summary of Chapter

If und chang g co d t f lif g being prese t d dual d re ce alm ry part f th tru t re and th ann t be d sp ted if th b ow g to the geo-

gan being t acl th and to th con ditio f lif ca g an f t d ty in truct re co t t t and l ab ts, t b ad antageo t th m t ld b m t tra rdinary fact f n t l d occ red usef l to ach be n lfare th sam man as so m y nat h occ ed sef l t man B t f n t sef l t any gan bei g d occ ass redly d d ls th haract sed w ll h th best chance f be preserved th truggl f lif d from th t g pri cipl f nh nt ance se ll t d t prod ce ff pri g m ilarly charact rised Th s pri l f prese ation, th v l f th fittest, I l called N t al Select It l ad t th m pro m t of ach re t re rel t to ts organic and in rganic co d t f lif and

d to th prod ct n t ral sed in f re gn l d Th ref e d n g the mod ficat n f th d sce dants f y spec and d g th ant t ggle f all pec to i crease numb s, th more d fied the descend ants becom the b tte w ll b the r ch nce f ccess th b ttl f l f Thu th m ll d ff re ce d t gu h g ari ti f th me pec t ad ly t d t in as t ll they eq l th gr te d ffe e ce B tw n p c es f the m g f d tinct gene W h seen th t t the common the w d ly-d ff ed and w d ly rang spec s b l g g to th larg r g n a w th n ach class wh ch ary m t and these t d t transm t t th modified ffsp g th t p ty wh ch n w m k th m dominant n th w co tri N l select as has ju t been remarked l ad to d g ce f ract nd to m ch tin ti f th l ss mpro ed d int rmediat f rms of l f On th se prin pl s, th n t re f th t d the g rally w ll-d fi ed distin t s be t een th m bl gani beings n h class thro gh t th w ld m y be explai ed

It is a truly wonderful fact—the wonder of which we are apt to overlook from familiarity—that all animals and all plants throughout all time and space should be related to each other in groups subordinate to groups in the manner which we everywhere behold—namely varieties of the same species most closely related species of the same genus less closely and unequally related forming sections and

orders sub classes and classes The several subordinate groups in any class cannot be ranked in a single file but seem clustered round points and these round other points and so on in almost endless cycles If species had been independently created no explanation would have been possible of this kind of classification but it is explained through inheritance and the complex action of natural selection entailing extinction and divergence of character as we have seen illustrated in the diagram

The affinities of all the beings of the same class have sometimes been represented by a great tree I believe this simile largely speaks the truth The green and budding twig may represent existing species and those produced during former years may represent the long succession of extinct species At each period of growth all the growing twigs have tried to branch out on all sides, and to overtop and kill the surrounding twigs and branches in the same manner as species and groups of *species have at all times overmastered other* species in the great battle for life The limbs *divided into great* branches, and these into lesser and lesser branches were themselves once when the tree was young budding twigs, and this connection of the former and present buds by ramifying branches may well represent the classification of all extinct and living species in groups subordinate to groups Of the many twigs which flourished when the tree was a mere bush only two or three now grown into great branches yet survive and bear the other branches so with the species which lived during long past geological periods very few have left living and modified descendants From the first growth of the tree many a limb and branch has decayed and dropped off and these fallen branches of various size may represent those whole orders families, and genera which have now no living representatives and which are known to us only in a fossil state As we here and there see a thin straggling branch springing from a fork low down in a tree and which by some chance has been favoured and is still alive on its summit so we occasionally see an animal like the Ornithorhynchus or Lepidosiren which in some small degree connects by its affinities two large branches of life and which has apparently been saved from fatal competition by having inhabited a protected station As buds give rise by growth to fresh buds and these if vigorous branch out and overtop on all sides many a feebler branch so by generation I believe it has been with the great Tree of Life which fills with its dead and broken branches the crust of the earth and covers the surface with its everbranching and beautiful ramifications

CHAPTER V

LAWS OF VARIATION

I ha e hith rto som times poken as if the var iatio s—so comm and mult f rm with ganic beings de d mest cat nd in a lesse degree with th se und r n ture—were d to hance This, f co rse is h lly in correct xpres ion, b t it serves to acknow

er xı pal ...

and mo trosit occ rri g m h m re fre q entl nd d m t cat n than u de na ture nd th gre t arıab lit f peci ha ing id rang s than f th se w th restri ted ranges, lead to th concl that riab l ty ıs g rall related to the co d tions f lif t hicl ach peci has bee posed d ring sev ral ccess g n r t ns. In th first hapt I tt mpted to sh w th t changed cond tions act in t w ys, d rectly th hole ganisat o certai parts l and nd rectl thro gh th reprod ti s t m. I all ases th re are t fact rs, th a t re of th rg ni m, wh ch m ch th most mportant of th two, and th t f th cond tions. Th d rect acti f changed co l tions lead t d fi t nd fi t res lts. In the latt case th ganisat seem t be com plastic and w b m ch fi t t g arıab l t I th f rm case th t re of th gan m cl th t t ll readil en bjected t certa co d t s, and all, m arl all th nd d als becom modi fied th sam

It is ry d ficult t decid l w f chang d ond tions, uch as of l m t food &c h acted d fi t man Th ere reaso t lieve that th co rse f t m th ffects h bee gre t than ca be pro d l y cl ar ev l nce B t w m saf l co l d th t th m ral l ompl co-ad pt t ns f tru t re hich w see thr gh t t re bet ee arious rganic beings, annot be ttrib ted simpl t uch action. I th f ll wing cases th cond tion seem t ha prod ced som slight d fi t ffect L F rbe asserts that sh lls at their so th rn lim t, and hen li ing shallow te are m re brightly coloured than those of the sam species from further n rth r from a greate d pth but th s cer tainl doe not alw ys h ld good Mr Go ld b l s th t birds f th s me species are m re brightly col ured u der a l ar atmo pl er than wh h ing n ar th coast o on isla ds, and W llaston convinced th t res dence n ar the sea affect the col u of insects. Moquin Tand n g es a l t f plants wh l wh n growing n ar the sea hore h th ir le ve in som d gree fleshy th ugh n t lsewhere fleshy These l ghtl arying organisms are int resti in as far as th y present cl aract rs l t th se possessed by the spec

any being ...

b t t th accum l t n acti n f natural select on, and l w m l t th c first act n f th co d ti ns of l fe. Thus, it is well kn wn

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d d l h ng been fa oured and preserved l n g man g n rat ns, and h w m ch to

... ...

Instances co ld be g n f milar ari t b in prod ced from the sam pec es und te nal co d t f lif as d ff re t as can w ll be co ce d nd n th th hand f d ssim lar et es b ing produ ed unde p pare tly th sam t rnal co d t ns A an nu me al l nstances re kn wn to e e y n t ralist, of peci keep g tru n t vary g t all, alth gh l g d th m t p po te lim t s. S ch co de ti ns as th se m h m to lay less w ght the direct a tion f th surr nd g co d t s, than n a tend y t ary d t causes f whi l w are q te g ant

In me se th co d t s of lif m y be said t l to cause ariab lity the di rectl and rectly b t l k w se to incl d nat ral select n, f th co d t ns d termin wh th this that ari ty shall rvi e B t wh n man is th selecting g t we clea ly ee that th two lements f change are distin t

variability is in some manner excited but it is the will of man which accumulates the variations in certain directions and it is this latter agency which answers to the survival of the fittest under nature

Effects of the increased Use and Disuse of Parts as controlled by Natural Selection

From the facts alluded to in the first chapter I think there can be no doubt that use in our domestic animals has strengthened and enlarged certain parts and disuse diminished them and that such modifications are inherited Under free nature we have no standard of comparison by which to judge of the effects of long-continued use or disuse for we know not the parent forms but many animals possess structures which can be best explained by the effects of disuse As Professor Owen has remarked there is no greater anomaly in nature than a bird that cannot fly yet there are several in this state The logger headed duck of South America can only flap along the surface of the water and has its wings in nearly the same condition as the domestic Aylesbury duck it is a remarkable fact that the young birds according to Mr Cunningham can fly while the adults have lost this power As the
flight
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now
inhabiting or which lately inhabited several oceanic islands tenanted by no beast of prey has been caused by disuse The ostrich indeed inhabits continents and is exposed to

that the progenitor of the ostrich genus had habits like those of the bustard and that as the size and weight of its body were increased during successive generations its legs were used more and its wings less until they became incapable of flight

Kirby has remarked (and I have observed the same fact) that the anterior tarsi or feet, of many male dung feeding beetles are often broken off he examined seventeen specimens in his own collection and not one had even a relic left In the *Onites apelles* the tarsi are so habitually lost, that the insect has been described as not having them In some other genera they are present but in a rudimentary condition In the Ateuchus or sacred beetle of the Egyptians, they are totally deficient. The evidence that accidental mutilations can be in

should make us cautious in denying this tendency Hence it will perhaps be safest to look at the entire absence of the anterior tarsi in Ateuchus and their rudimentary condition in some other genera not as cases of inherited mutilations but as due to the effects of long continued disuse for as many dung feeding beetles are generally found with their tarsi lost this must happen early in life therefore the tarsi cannot be of much importance or be much used by these insects

In some cases we might easily put down to disuse modifications of structure which are wholly or mainly due to natural selection Mr Wollaston has discovered the remarkable fact that 200 beetles out of the 550 species (but more are now known) inhabiting Madeira are so far deficient in wings that they cannot fly and that of the twenty nine endemic genera no less than twenty three have all their species in this condition! Several facts — namely that beetles in many parts of the world are frequently blown to sea and perish that the beetles in Madeira as observed by Mr Wollaston lie much concealed until the wind lulls and the sun shines that the proportion of wingless beetles is larger on the exposed Desertas than in Madeira itself and especially the extraordinary fact so strongly insisted on by Mr Wollaston that certain large groups of beetles elsewhere excessively numerous which absolutely require the use of their wings are here almost entirely absent —these several considerations make me believe that the wingless condition of so many Madeira beetles is mainly due to the action of natural selection combined probably with disuse For during many successive generations each individual beetle which flew least either from its wings having been ever so little less perfectly developed or from indolent habit will have had
being
the
would
to sea and thus destroyed

The insects in Madeira which are not ground feeders and which as certain flower feeding coleoptera and lepidoptera, must habitually use their wings to gain their subsistence have as Mr Wollaston suspects their wings not at all reduced but even enlarged This is quite compatible with the action of natural selec

tion. For when a n w insect first arr ed on the island, the tendency of tural selecti n to n large or to reduce th wi gs, wo ld d pend on hethe a great r number f ind d als w re sa ed by successfully battling w th the winds, r in giv un the tt mpt and rarely n r

urtue ... as the bad swimm rs if th y had n t been able to swim at all and had t ck to th wreck.

The es of moles and of som b rrowi g ro-dents are rudimentary n iz and in som cases are quite co ered b skin and f Thus stat of the es is probably d to gradual re-ductio from disuse b t aided pe haps by natural selectio I So th Am ri a, a b rrow g rod t, th t cot co o Ct om s, s e en

as es are certainly n t ecessary to an mals havi g s bterran an hab ts, a red t in thei size, with the adhes of th lids and gro th of fur th m, m ght in ch case be an ad antag and if so nat ral select would aid the ffects of d suse

It is w ll known th t se ral animals, be-longing to th most d ff re t lasses, wh h in hab t the ca of Carn la and f K t cky are blind I som of th crabs th foot talk f th remai s, tho gh th is g — the tand f th t lescope th re th gh th telescope w th ts glasses has bee lost. As t is difficult t magine that es, tho gh useless, co ld be an w jurio to animals li ng darkness, their loss ma be ttrib ted to disuse I one of th blind mals, nam l the ca rat (Neotoma) two of wh h w re capt red b Professo Sill man t bo half m le listance from th mo th f tl ca and therefore not th prof undest d p this, tl es w re lustrous and of larg size and these an mals, as I am nf rmed b Professo S lli-man, aft ha ing bee posed f abo t month to graduated light, acquired dim perception of objects.

It is difficult to magi cond tions of li more similar than deep limesto ca erns u der nearly similar climate so that, in ac-cordance with th old view f the blind ani mals h ving been separatel created f r the Am rican and European caverns, ery close similarity in th ir organisati n and affiniti s h bee expected This is certainly

f w f rms between the Mammoth ca (in K t cky) and the ca in Carn la, other wise than as a ry plain xpression of that analogy wh ch bsists g rally between the fauna f Europe and of North Am rica. On my v w we must ppose that American ani mals, ha ing in most cases ordinary powers of vi slowl m grated b ccessi g nera tio from the t w ld t th deepe and deeper recesse f the Kent cky ca es, as did European animals to th a s of Europe. W ha e som d nce f this grad ti n of hab t fo as Schiodte remarks, W accord ingl look pon the bt rran an f nas as mall ram fications wh ch ha pen trated in to the arth from the geograph call l m ted f nas f th adj cent tracts, and which as th y t ded th msel into darkness, h been accommod ted to u rounding circum tances. Animals n t far remot from rdinary f ms, prepare the trans ti from light t d kn ss. N t f ll w tl se that are co tru ed f tw l ght and last f all those d tined f t tal darkn ss, and wh se f rmation quit peculiar Tl ese remarks f Schiodt t sh ld be und rstood, ppl not to the sam b t t dist t pec s. B the time th t an an mal had reached, aft n mbe less g ti ns, th deepe t recesses, di use will n th w ha m re less perfectly blit rated its es, and nat ral selection will lt n ha e f fected oth chang s, ch as an in rease n the l gth f the ant nnæ palpi, as compensa ti f blindn ss. N tw thstanding u h mod ificati ns, w m gl t expect till to see in th ca e-animals of Am a, affiniti t th th inhab tants of that co tin nt, and in th se f Europe to th hab tants f th European continent. And thi is th case with som f th Am rican ca e-animals, as I h ar from Pro-fessor Dana and som f th European ca

tants of the two continents on the ordinary view of their independent creation. That several of the inhabitants of the caves of the Old and New Worlds should be closely related, we might expect from the well-known relationship of most of their other productions. As a blind species of Bathyscia is found in abundance on shady rocks far from caves, the loss of vision in the cave-species of this one genus has probably had no relation to its dark habitation; for it is natural that an insect already deprived of vision should readily become adapted to dark caverns. Another blind genus (Anophthalmus) offers this remarkable peculiarity, that the species, as Mr. Murray observes, have not as yet been found anywhere except in caves; yet those which inhabit the several caves of Europe and America are distinct; but it is possible that the progenitors of these several species, whilst they were furnished with eyes, may formerly have ranged over both continents, and then have become extinct, excepting in their present secluded abodes. Far from feeling surprise that some of the cave-animals should be very anomalous, as Agassiz has remarked in regard to the blind fish, the Amblyopsis, and as is the case with the blind Proteus with reference to the reptiles of Europe, I am only surprised that more wrecks of ancient life have not been preserved, owing to the less severe competition to which the scanty inhabitants of these dark abodes will have been exposed.

Acclimatisation

Habit is hereditary with plants, as in the period of flowering, in the time of sleep, in the amount of rain requisite for seeds to germinate, &c., and this leads me to say a few words on acclimatisation. As it is extremely common for distinct species belonging to the same genus to inhabit hot and cold countries, if it be true that all the species of the same genus are descended from a single parent-form, acclimatisation must be readily effected during a long course of descent. It is notorious that each species is adapted to the climate of its own home: species from an arctic or even from a temperate region cannot endure a tropical climate, or conversely. So again, many succulent plants cannot endure a damp climate. But the degree of adaptation of species to the climates under which they live is often overrated. We may infer this from our frequent inability to predict whether or not an imported plant will endure our climate, and from the number of plants and animals brought from different countries which are here perfectly healthy. We have reason to believe that species in a state of nature are closely limited in their ranges by the competition of other organic beings quite as much as, or more than, by adaptation to particular climates. But whether or not this adaptation is in most cases very close, we have evidence with some few plants, of their becoming, to a certain extent, naturally habituated to different temperatures; that is, they become acclimatised: thus the pines and rhododendrons, raised from seed collected by Dr. Hooker from the same species growing at different heights on the Himalaya, were found to possess in this country different constitutional powers of resisting cold. Mr. Thwaites informs me that he has observed similar facts in Ceylon; analogous observations have been made by Mr. H. C. Watson on European species of

duced of species having largely extended, within historical times, their range from warmer to cooler latitudes, and conversely; but we do not positively know that these animals were strictly adapted to their native climate, though in all ordinary cases we assume such to be the case; nor do we know that they have subsequently become specially acclimatised to their new homes, so as to be better fitted for them than they were at first.

As we may infer that our domestic animals were originally chosen by uncivilised man because they were useful, and because they bred readily under confinement, and not because they were subsequently found capable of far-extended transportation, the common and extraordinary capacity in our domestic animals of not only withstanding the most different climates, but of being perfectly fertile (a far severer test) under them, may be used as an argument that a large proportion of other animals now in a state of nature could easily be brought to bear widely different climates. We must not, however, push the foregoing argument too far, on account of the probable origin of some of our domestic animals from several wild stocks: the blood, for instance, of a tropical and arctic wolf may perhaps be mingled in our domestic breeds. The rat and mouse cannot be considered as domestic animals, but they have been transported by man to many parts of the world, and now have a far wider range than any other rodent; for they live under the cold climate of Faroe in the

orth and of the Falklands m th so th, and on many an island in th torrid zones. He ce adapt io t y special climate may be lool

cat

to most animals

enduring the most d ff re t climates by man himself and b d m t c animals, and the fact of th extinct lephant and *rhinoceros* having formerly ndured a glac al climate, hereas th h ing pecies are w ll trop cal or *sub-tropical in th ir hab ts, gl t ol to be looked* t as anomalies, b t as examples f a ery common flex bilit f constit ti n, brought, und r peculiar circumstances, into action.

H w much of th accl m tisatio of speci *to any peculiar climat is du t m re hab t* and how much t th nat ral selecti n f *ari ties ha ing d ff re t* inn t constit ti ns, and how much to both m ans comb ed, is an obscure q estion. That hab t custom has some infl nce I must bel both from analogy and from th ncessant ad ce gi n agricult ral wo ks, en in th anc nt n cy lopedias of China, to be ry cautio in transporting an mals from district t an other And as t is n t likel that man sh ld ha ucceeded in selecting so man breeds and b-breeds with con titutions pecially fitted f their wn distri ts, th result must, I thi k, be d t hab t. On th the hand, natural selectio would in tably te d t preser those ind iduals which w re born w th const t tions best ad pted t any country hich th y nhab ted I treatises many kind of cult ated plants, certain ari ties are said to w thstand certain limates bett r than th rs this is strikingly sh wn in orks fru t trees p blished in th U ted States, in hich certain ari ties are hab tually recommended for the north rn and th rs f th southern States and as most of these ari ties are of rece t rigin, th y cannot w their co st t tional diff rences to hab t. Th case of th J rusalem artichok which is ropagated in En land by seed and of which co sequently new ariet es ha not been produced, has e been ad anced, as pro that acclimatisatio annot be ffected f t is now as tender as er t was Th case also, of the kidn -bean has been *often cited for a* similar p rpose and th much gre t weight b t l someone will sow t rn a score of generations his kid beans so arly that a ery large proportion re destroyed by frost, and th n collect seed from the f w surviv rs, w th care to pre ent accid ntal crosses, nd th n again g t seed from these seedli gs, w th th sam precauti ns, th periment cannot be said t have been tried N r let it be supposed th t d ff rences in th co t t t n of seedlin k dn y beans r ppear f r an account has been p blished h w m ich more hard som seedli g are than thers and of this fact I ha myself bserved st iking in ta ces.

O th wh l we m y co cl d th t hab t or use and d suse ha *n some cases,* pl yed a cons d rabl part n th mod ficati n of th e constit tion and stru t re b t th t th f fect ha oft n been largely combined with and som time o ma t red by th natural selection f innat n ti ns.

Correlated Variation

I m an by th xpress on th t th wh l rganisati n *so tied tog th dur n* ts growth and d l pm nt tl t when light ari tions in a y one pa t occu and are cum lated thro gh natural selecti n otl r parts become mod fied This is a very impo tant bject most imperfectly und rstood and d bt wh lly d ff rent classes of facts ma be h re easily confo ded t geth We shall presently see that simple inheritance

larvæ naturally tend to affect the tructure of the m ture animal Th sev ral parts f the body which are h m log us, and wh ch t an ea ly embry n period are id t cal in tru t re and which are ecessarily posed to sim lar co diti ns, seem minently liabl to vary in lik mann w see this in the ri ht and l ft sides f th body varying in th same manner in the front and hind l gs, and n in th j w and limbs, ry g t th l the low j w is beli ed by *som an t mists to be h m* log us w th th limbs. Th se t nd n s, I d t d bt m y be mast red m re or l ss com pl t ly by nat al selection thus a fam ly of tags nce existed with an antl nly on e si and if this had been f any gre t use to th breed, t m gl t probably ha been ren d red permanent by selecti n.

H mologous parts, as has been remarked by som th rs, t nd t col re this i oft n seen in m nstro plants and n thing is m re common than th unio f h m lo us parts in n rmal tructures, as in th union of the petals

into a tube Hard parts seem to affect the form of adjoining soft parts it is believed by some authors that with birds the diversity in the shape of the pelvis causes the remarkable diversity in the shape of their kidneys Others believe that the shape of the pelvis in the human mother influences by pressure the shape of the head of the child In snakes according to Schlegel the form of the body and the manner of swallowing determine the position and form of several of the most important viscera

The nature of the bond is frequently quite obscure Isidore Geoffroy St Hilaire has forcibly remarked that certain malconformations frequently and that others rarely co exist without our being able to assign any reason What can be more singular than the relation in cats between complete whiteness and blue eyes with deafness or between the tortoise shell colour and the female sex or in pigeons between their feathered feet and skin betwixt the outer toes or between the presence of more or less down on the young pigeon when first hatched with the future colour of its plumage or again the relation between the hair and teeth in the naked Turkish dog though here no doubt homology comes into play? With respect to this latter case of correlation I think it can hardly be accidental that the two orders of mammals which are most abnormal in their dermal covering viz Cetacea (whales) and Edentata (armadilloes scaly ant eaters &c) are likewise on the whole the most abnormal in their teeth but there are so many exceptions to this rule as Mr Mivart has remarked that it has little value

I know of no case better adapted to show the importance of the laws of correlation and variation independently of utility and therefore of natural selection than that of the difference between the outer and inner flowers in some compositous and umbelliferous plants Every one is familiar with the difference between the ray and central florets of for instance the daisy and this difference is often accompanied with the partial or complete abortion of the reproductive organs But in some of these plants the seeds also differ in shape and sculpture These differences have sometimes been attributed to the pressure of the involucra on the florets or to their mutual pressure and the shape of the seeds in the ray florets of some Compositæ countenances this idea but with the Umbelliferæ it is by no means as Dr Hooker informs me the species with the densest heads which most frequently differ in their inner and outer flowers It might have been thought that the development of the ray petals by drawing nourishment from the reproductive organs causes their abortion but this can hardly be the sole cause for in some Compositæ the seeds of the outer and inner florets differ without any difference in the corolla Possibly these several differences may be connected with the different flow of nutriment towards the central and external flowers we know at least that with irregular flowers those nearest to the axis are most subject to peloria, that is to become abnormally symmetrical I may add as an instance of this fact and as a striking case of correlation that in many pelargoniums the two upper petals in the central flower of the truss often lose their patches of darker colour and when this occurs the adherent nectary is quite aborted the central flower thus becoming peloric or regular When the colour is absent from only one of the two upper petals the nectary is not quite aborted but is much shortened

With respect to the development of the corolla Sprengel s idea that the ray florets serve to attract insects whose agency is highly advantageous or necessary for the fertilisation of these plants is highly probable and if so natural selection may have come into play But with respect to the seeds it seems impossible that their differences in shape which are not always correlated with any difference in the corolla can be in any way beneficial yet in the Umbelliferæ these differences are of such apparent importance—the seeds being sometimes orthospermous in the exterior flowers and cœlospermous in the central flowers —that the elder De Candolle founded his main divisions in the order on such characters Hence modifications of structure viewed by systematists as of high value may be wholly due to the laws of variation and correlation without being as far as we can judge of the slightest service to the species

We may often falsely attribute to correlated variation structures which are common to whole groups of species and which in truth are simply due to inheritance for an ancient progenitor may have acquired through natural selection some one modification in structure and after thousands of generations some other and independent modification and these two modifications having been transmitted to a whole group of descendants with diverse habits would naturally be thought to be in some necessary manner correlated Some other

correlat ns are pparc tly d e to tl e man n hich t ral select n al act F r in tance, Alph. de Candolle has em Led th t win ed seeds are n e f d i f u ts whi h d or I l ld xplam th s rule by th

fact with wh ch I was much struck wh n e am m r ned and of which many an l g us in l ci anu pl t case rdir carapace in all the p u three h ghly impo ta t a t ri segm t of h l d m ly d l ped and f rn shed

C mpensation and Economy of Growth

Th ld Geoff y and Go the propounded t abo t th sam tim th law f compensation o balancem t f growth as Goethe xpressed t, In rd t pe d n de t re f rced t eco mis th th de. I th k this h lds tru t certai xt t w th d mest c prod cti ns if no rishm t fl w to o part n gan in ce s, it arely fl ws, t l ast e cess, t an tl p rt thu it d fficult to g t cow to g m ch milk and to f tt readily Th sam ar t es of th cabb g d n t y eld ab dant and triti fol g and cop us pply f o l b ri g eed Wl the seeds n fru ts becom t ophi ed th fru t tself gains larg ly in and qual ty I po ltry a larg t ft f f th ra on tl h ad is g ally accomp ed by a d m ished comb and large b ard by d min ished wattles. W th pec s in a tate f t t hardl be maintai ed th t th l w f rsal pplicat but many good bservers, m re pec ally botanists, b h ts truth. I w ll t, h here g any in tances, f I see hardly any way f d tin guisl g betwee th ffects, on th hand f part b g larg ly d l ped tl ro gl n t ral select and an tl d adj g part be g red ced l y th m process by d se and th tl l and th act al w th d al of trim t from part g to th cess f growth an th and adj ning part.

I pect, also, th t some f th case f compensat whi h l bee ad anced and l k ise som th facts, may b m ged und m re ge al pri pl am ly th t ıat al selecti co t lly try g to economise ry part f th g zat If u d har ged cond tions of l f tru t re bef re sef l, becomes less sef l ts d m t w ll be f red, f t will prof t tl nd d al t to ha trim t asted b ld g p an useless tructure I can ly th d rstand

b l each w uld h a b tt r chan e f s pport its lf by le triment be g wasted

Thus as I belie tural s lect n will tend in the l g run to ed e any pa t of th r gan ati as soon as it becom thr gh h ged h b ts, s perfl o witho t by any m an ca ing som oth r p rt to b l g ly d l ped in a co e po d ng deg e A d con rs ly th t tural s lect n m y p r fectly w ll cceed in f g ly d v l p g an o gan w th t q g as a neces ary com p nsation the d tio f some adjoin ng part.

Multiple Rudimentary and Lowly organised St uctu es are Variable

It seems t b a rul as emarked by th y g Geoffroy both with ri t s d pec th t wh n y part gan p ted m y t m the sam ind d l (as th rt bræ snak s, and the t me s n polyandro fl w rs) th n mb r is ble wh reas th sam p rt organ wh n it oc rs in lesse n mb rs, s onstant. Th sam as w ll as som bota ts h v furth remarked that m ltipl p t are trem ly habl to ary tru ture As eg t bl p t t use Prof O xp ss n, s a s gn f l w gan sat th f going tat m ts acco d w th th comm n pin n f t ts, that be g whi h ta d l n the scal f t re are m re ar bl than those wh ch re h gl r l pre m that lown ss h m ans th t th se al part f th g nisa ti n h bee b t little pecialised f par ticular fun ti ns and as l g as th sam part

has to perform diversified work, we can perhaps see why it should remain variable, that is, why natural selection should not have preserved or rejected each little deviation of form as carefully as when the part has to serve for some one special purpose. In the same way, a knife which has to cut all sorts of things may be of almost any shape; whilst a tool for some particular purpose must be of some particular shape. Natural selection, it should never be *forgotten*, can act solely through and for the advantage of each being.

Rudimentary parts, as it is generally admitted, are apt to be highly variable. We shall have to recur to this subject; and I will here only add that their variability seems to result from their uselessness, and consequently from natural selection having had no power to check deviations in their structure.

A Part developed in any Species in an extraordinary degree or manner, in comparison with the same Part in allied Species, tends to be highly variable.

Several years ago I was much struck by a remark, to the above effect, made by Mr. Waterhouse. Professor Owen, also, seems to have come to a nearly similar conclusion. It is hopeless to attempt to convince any one of the truth of the above proposition without giving the long array of facts which I have collected, and which cannot possibly be here introduced. I can only state my conviction that it is a rule of high generality. I am aware of several causes of error, but I hope that I have made due allowance for them. It should be understood that the rule by no means applies to any part, however unusually developed, unless it be unusually developed in one species or in a few species in comparison with the same part in many closely allied species. Thus, the wing of a bat is a most abnormal structure in the class of mammals; but the rule would not apply here, because the whole group of bats possesses wings; it would apply only if some one species had wings developed in a remarkable manner in comparison with the other species of the same genus. The rule applies very strongly in the case of secondary sexual characters, when displayed in any unusual manner. The term, secondary sexual characters, used by Hunter, relates to characters which are attached to one sex, but are not directly connected with the act of reproduction. The rule applies to males and females; but more rarely to the females, as they seldom offer remarkable secondary sexual characters. The rule being so plainly applicable in the case of secondary sexual characters, may be due to the great variability of these characters, whether or not displayed in any unsusual manner—of which fact I think there can be little doubt. But that our rule is not confined to secondary sexual characters is clearly shown in the case of hermaphrodite cirripedes; I particularly attended to Mr. Waterhouse's remark, whilst investigating this Order, and I am fully convinced that the rule almost always holds good. I shall, in a future work, give a list of all the more remarkable cases; I will here give only one, as it illustrates the rule in its largest application. The opercular valves of sessile cirripedes (rock barnacles) are, in every sense of the word, very important structures, and they differ extremely little even in distinct genera; but in the several species of one genus, Pyrgoma, these valves present a marvelous amount of diversification; the homologous valves in the different species being sometimes wholly unlike in shape; and the amount of variation in the individuals of the same species is so great that it is no exaggeration to state that the varieties of the same species differ more from each other in the characters derived from these important organs, than do the species belonging to other distinct genera.

As with birds the individuals of the same species inhabiting the same country vary extremely little, I have particularly attended to them, and the rule certainly seems to hold good in this class. I cannot make out that it applies to plants, and this would have seriously shaken my belief in its truth, had not the great variability in plants made it particularly difficult to compare their relative degrees of variability.

When we see any part or organ developed in a remarkable degree or manner in a species, the fair presumption is that it is of high importance to that species: nevertheless it is in this case eminently liable to variation. Why should this be so? On the view that each species has been independently created, with all its parts as we now see them, I can see no explanation. But on the view that groups of species are descended from some other species, and have been modified through natural selection, I think we can obtain some light. First let me make some preliminary remarks. If, in our domestic animals, any part or the whole animal be neglected, and no selection be ap-

t n tance, th comb in th

full play and thus to ... fluctuating cond tion. B t what h re more particularly concern is, that those po ts in our d mestic animals, wh ich at th prese t tim are und rgoin rapid cha by co tin ued selection, are also emin tl liabl to var iation. Look at th indi d als of th sam breed of th pigeon, and see what a prod gious amount of diff rence th re is in the beaks of tumblers, in th beaks and w ttle of carr rs, in the carriage and tail of fantails, &c., these being the points n w mainl tt nded to by English fanciers. E en th sam ub-breed as in that of the sho t-faced t mble t i notorious difficult t breed arl perfect birds, man departi g wid l from th stand ard. There ma truly be said to be con tant struggle going o between, o th hand, the tendency to rev rsio to less perfect tate as w ll as an inn t tend ncy t w variations, and, th the hand, the pow of stead selectio to keep th breed tru In th long run selectio gains th d and w do not xpect t fail so compl t l as to breed a bird as coarse as comm t mbl p eon from good short faced train. B t as lo as selectio is rap dl goin on, m h ariabilit in the parts und rgoi mod fication ma al y be expected

N w let us t rn t nature Wh n part has been d loped an traordi nary mann n any one pecies, compared w th th oth species of the sam g us, w ma oncl d that this part has un I rgon an traordi nary amount of mod ncation since the period wh n the se eral pecies b anched off from th com mon progenito of th genus. This period will seldom be remot in an trem d ree as pecies rarely end re f more than geo logical period. An extraordi nary amount of modification implie an usuall larg and long-cont ued mou t of riab lity which has continuously bee accum lated by natural selection f the ben fit of the pecies. B t as the ariability of the traordinarily d l oped part or organ has bee so great and long continued within period not xcessi ely re-

mot to fin. th e parts of th ... m ich lo er period arly con

co rse of tim cease and that th most ab normally d loped rgan ma be mad con ta t I see no reason to do bt. H nce wh n ... ev r abnormal may be h s

... existed ccordin to o theory f r an im mense period in nearly the same tat and th it has om not to be more variable than

... of th nd luals arving in th required man n and d ree and b th co t n ed rejection of those t nd t re rt t a former and less modified condition.

Spec fic Ch racters mo e V ariable than Ge e ic Ch acters

The principle discussed under th last head m may be pplied t present s bject. It is not rious that pecific chara t rs are more var iabl than g n ric. To xplain b a imple e mple what is meant if in a large nus of plants som species had bl fl rs and som had red, th colou would be onl a specifi haract and n would be surprised at ne of th blu spec es arvin int red, o con rsel b t if all th spec es had bl flow rs, th colo w uld becom a gen ric haracter and its ariatio w ld be a more unusual cir cumstance. I hav hosen this example be cause the plan tion which most naturalists w uld ad ance is n t h re pplicable nam l that pecific haract rs are more variable than generic, bec use th y are tak n from parts of less ph siological importance than those com m nly used for classin gen ra. I beli e this explanatio partly et onl indirectl tru I shall, how ha t ret rn to this point in the chapt on Classification. It w uld be al most perfluou to add ce nd nce in s p port of the statement, that ordinary specific

characters are more variable than generic but with respect to important characters I have repeatedly noticed in works on natural history that when an author remarks with surprise that some important organ or part which is generally very constant throughout a large group of species *differs* considerably in closely allied species it is often *variable* in the individuals of the same species And this fact shows that a character which is generally of generic value when it sinks in value and becomes only of specific value often becomes variable though its physiological importance may remain the same Something of the same kind applies to monstrosities at least Isidore Geoffroy St Hilaire apparently entertains no doubt that the more an organ normally differs in the different species of the sam

l ... p uently created why should that part of the structure which differs from the same part in other independently created species of the same genus be more variable than those parts which are ...

... y marked and fixed varieties we might expect often to find them still continuing to vary in those parts of their structure which have varied within a moderately recent period and which have thus come to differ Or to state the case in another manner —the points in which all the species of a genus resemble each other and in which they differ from allied genera are called generic characters and these characters may be attributed to inheritance from a common progenitor for it can rarely have happened that natural selection will have modified several distinct species fitted to more or less widely-different habits in exactly the same manner and as these so-called generic characters have been inherited from before the period when the several species first branched off from their common progenitor and subsequently have not varied or come to differ in any degree or only in a slight degree it is not probable that they should ...ary

... he

... ies

... cters

and as these specific characters have varied and come to differ since the period when the species branched off from a common progenitor it is probable that they should still often be in some degree variable—at least more variable than those parts of the organisation which have for a very long period remained constant

Secondary Sexual Characters Variable—I think it will be admitted by naturalists, without my entering on details that secondary sexual characters are highly variable It will also be admitted that species of the same group differ from each other more widely in their secondary sexual characters than in other parts of their organisation compare for instance the amount of difference between the males of gallinaceous birds in which secondary sexual characters are strongly displayed with the amount of difference between the females. The cause of the original variability of these characters is not manifest ...

... on ... ordinary selection as it does not entail death but only gives ...

... ey are highly variable sexual selection will have had a wide scope for action and may thus have succeeded in giving to the species of the same group a greater amount of difference in these than in other respects

It is a remarkable fact that the secondary differences between the two sexes of the same species are generally displayed in the very same parts of the organisation in which the species of the same genus differ from each other Of this fact I will give in illustration the two first instances which happen to stand on my list and as the differences in these cases are of a very unusual nature the relation can hardly be accidental The same number of joints in the tarsi is a character common to very large groups of beetles but in the Engida as Westwood has remarked the number varies greatly and the number likewise differs in the two sexes of the same species Again in the fossorial hymenoptera the neuration of the wings is a character of the highest importance because common to large groups but in certain genera the neuration differs in the different species and likewise in the two sexes of the same species Sir J Lubbock has recently remarked that several minute crustaceans offer excellent illustrations of this law In Pontella for instance the sexual characters are afforded mainly by the anterior antennæ and by the fifth pair of legs the specific differences also are principally given by these organs This

rel tion has a clear meani g n my vi w I look t ll th spec es f th sam as h v ng as certa ly descended f m comm p g n t h tw se e f ny pec es. C

part

t f by t al and e u l select n rd r to fit the se al pec t tl se e al places the eco my f nat and l k w e t fit the tw se es f th same pec e to ach tl to fit th m l t truggl w th th r m l f the poss ss o f th f m le

F nally th n, I co l d that tl great r variab l ty f pec f laract rs th se h l d t gu l speci from pec e than f g ric charact s, r tl se wl ch re po s sed by all the pec —th t tl f q t trem n b l t f any pa t wl l d l p ed spec t aord y m nn comp ar so w tl tl sam part t co g rs and th l ght d gre f n b l ty a part, l traord nly t ma b d loned f t be comm t wl le gro p f

se al and rd rs pec fi d ll re ce re g ally displayed tl sam parts f th

h l rited m l omm —t p rts t cl l rece tl and l g l ned b g m re l k ly t ll t g rs g tl an g ts h l l lo g bec l ted d l ed —to nat l sel ct l g m re o l s compl t l accord g t l pse f t m rs asl red tl t d t re rs and to f tl ariab lit —t se l select b g less rigid than rd select —and to nat m tl sam parts h g bec ac cu lated by t ral l se l sel ct ar l t g bec tl ad pted f seco dary se l an l f l ary p rposes.

That ct Spec p ale l rs f that l riety f Sp cie fi as m Character pr per l all d Spec re rt t m f tl Ch acter f ea l l o- g —Th se propo tio w ll be most read l nd rstood b look g t l the are Tl most l t t breed f tl p geo cou tries l ly part prese t l ar t th re ersed f tl rs tl l ad and th

f ath s n th feet,—cl racte s not po ses ed by th rig nal rock p geon th th n a e anal gous tio s n two o m r di tinct races Tl f eq ent p nc f f u teen or n sixt n tail f the s n the p ter m y b co d red as a vari t n rep ese t g the no mal tructu e of an the ace th fan ta l I p e m th t e w ll d ubt that all such an logo s ari t s re d t the se al race f the p geon ha inh r ted f om a comm n pare t tl m const tut on and ten d n y to t n hen ct d n by milar unkn wn nfl nce In tl e eg tabl kingd m w l a case f a al u ar t n m th l d t ms as commo ly alled roots f

th b n t o th case will th n be o r an g u ar t n n t o o-call d d tin t pe cies and t these th d m y be added nam ly tl comm n t rn p Accord g t the d n

three plant n t to the re a a of commu t f d see t, and co seq nt tend n y to vary m lik ma n but t thre sep t y t l sely r lated ts f c t n. Many m l cases f an l g u ari t n ha been b er d by din n tl gr t g rd f m ly and by ar utl m r ce l S m lar

b rs th w gs, wl t l ns a b t th d f tl tail w th tl te feath t rn lly edged th bas with wh t ks all th se m ks re haract ri t f tl e p t rock p geo I pre um th t n w ll d bt tl t ll is case f ion, and t f w t nal t n ppe ing n th se l breed W m y I th k confid tly com t tl concl beca as w l se th col red k re m ntly l ble t ppe r th rossed ffsp g f tw distin t d d ff tly col red breed d th ase tl re is noth g m th t rnal co d t ns f ll to ca se tl re ppe ce f th sl ty bl w tl th se l m ks, b nd tl infl nce of tl m re act f crossing the law f in h ritance.

No doubt it is a very surprising fact that characters should reappear after having been lost for many, probably for hundreds of generations. But when a breed has been crossed only once by some other breed, the offspring occasionally show for many generations a tendency to revert in character to the foreign breed—some say, for a dozen or even a score of generations. After twelve generations, the proportion of blood, to use a common expression, from one ancestor, is only 1 in 2048; and yet, as we see, it is generally believed that a tendency to reversion is retained by this remnant of foreign blood. In a breed which has not been crossed, but in which *both* parents have lost some character which their progenitor possessed, the tendency, whether strong or weak, to reproduce the lost character might, as was formerly remarked, for all that we can see to the contrary, be transmitted for almost any number of generations. When a character which has been lost in a breed, reappears after a great number of generations, the most probable hypothesis is, not that one individual suddenly takes after an ancestor removed by some hundred generations, but that in each successive generation the character in question has been lying latent, and at last, under unknown favourable conditions, is developed. With the barb pigeon, for instance, which very rarely produces a blue bird, it is probable that there is a latent tendency in each generation to produce blue plumage. The abstract improbability of such a tendency being transmitted through a vast number of generations, is not sometimes thus inherited.

As all the species of the same genus are supposed to be descended from a common progenitor, it might be expected that they would occasionally vary in an analogous manner; so that the varieties of two or more species would resemble each other, or that a variety of one species would resemble in certain characters another and distinct species,—this other species being, according to our view, only a well marked and permanent variety. But characters exclusively due to analogous variation would probably be of an unimportant nature, for the preservation of all functionally important characters will have been determined through natural selection, in accordance with the different habits of the species. It might further be expected that the species of the same genus would occasionally exhibit reversions to long lost characters. As, however, we do not know the common ancestors of any natural group, we cannot distinguish between reversionary and analogous characters. If, for instance, we did not know that the parent rock pigeon was not feather-footed or turn-crowned, we could not have told whether such characters in our domestic breeds were reversions or only analogous variations; but we might have inferred that the blue colour was a case of reversion from the number of the markings, which are correlated with this tint, and which would not probably have all appearing when differently coloured breeds are crossed. Hence, although under nature it must generally be left doubtful, what cases are reversions to formerly existing characters, and what are new but analogous variations, yet we ought, on our theory, sometimes to find the varying offspring of a species assuming characters which are already present in other members of the same group. And this undoubtedly is the case.

The difficulty in distinguishing variable species is largely due to the varieties mocking, as it were, other species of the same genus. A considerable catalogue, also, could be given of forms intermediate between two other forms, which themselves can only doubtfully be ranked as species; and this shows, unless all these closely allied forms be considered as independently created species, that they have in varying assumed some of the characters of the occasionally vary so as to resemble in some degree the same part or organ in an allied species. I have collected a long list of such cases; but here, as before, I lie under the great disadvantage of not being able to give them. I can only repeat that such cases certainly occur, and seem to me very remarkable.

I will, however, give one curious and complex case, not indeed as affecting any important character, but from occurring in several species of the same genus, partly under domestication and partly under nature. It is a case almost certainly of reversion. The ass sometimes has very distinct transverse bars on its legs, like those on the legs of the zebra: it has been asserted that these are plainest in the

foal, and, from inq ines which I ha e made, I bel thus t be true Th tripe on the should s sometimes d bl and is ery ariable length and tl A white ass, but not an all o, has been described w th ut eith r sp nal r sh ld r tripe and these tripes are som times v obscure or act ally quit lost, . dark-col ured asse The k ulan of Pallas said to ha bee een w th a d u ble h ld tripe, Mr Bl th has seen a pecimen of tl hemio us w th a d tinct ll t pe ll ugh t prope l has n

zebra e tl e bod is with t bars n the leg b t D Gray has f gured specim n th ery d bra lik b rs n the hocks.

W th respect t th h se I h e collected ases E gland f th p ial t pe in h rses of the most d t t breeds, d f all col trans rse b rs tl l g re t are in d ns, mouse-duns, a l in o nst e hest t faint hould t pe v som t mes be seen in d ns, nd I h see a trace in b y l orse My so mad carel l e an tio d k tch for m of dun B lg art l rse th d u ble tripe ad h ll d w th l g stripes I ha myself see 1 D nshire pon and mall d W l l po y l as been caref ll described t m both w th th e parallel tripes ach l ld

I tl rtl west pa t f I d th katty ar breed f h rses so g rally triped that, I l from C l ll ool wh xam in l tl breed f th Ind G mm t, horse tl out t pes t co s l red as pur l -bred The p l y triped the are g nerally barred an l tl l ld tripe, hich is som t mes d bl an l some tim trel l is comm tl l of tl face morea is som ti t ped Tl tripes are of plainest th foal and som t mes q t d sappear old l sea. Col l Pool has seen both g m l l katt war h se striped h fi t foaled I ha also reaso t su pect, from i f rmat g m l M W W Ed ards, tl t th th E glish racehorse th p nal tripe much e m m tl foal than in the f llgro mal. I ha m self recentl bred f al from bay mare (offsp ring of T k man horse and Flemish mare) by bay English acehorse this foal when a week old as marked on its hind quart rs and

its forehead with numerous, very narrow dark ebra like bars, and its legs w e feebly tr ped all the tripes soon d sappeared complet ly W tl ut h re ent ring n furth r d tail I may stat that I have collected case of l g and sh ld r trip s in h ses f v ry diffe ent breeds in ar s countr es f m Britain to eastern Chin nd from N rw y in the n tl to th Mal y Arch pelag in th south In all parts f the wo ld these tripes occur far often est in duns and m use-d n b tl e term d n larg ra g of col ur is incl ded, from o e betwee brown and black to cl se approach t m col

un se al o us
from se ral abo ginal pecie —one f wh ll the d as t ped nd th t th abo descr bed ppearan es a e ll d t anci t cro ses w th th du tock B t tl w m y b safely rejected f it is h gl ly mprobabl tl t tl e hea y B lg an c t h se W lsh

o e pposed abori inal stock

N w l t us t rn to the ffect f rossin th sev al pecies f th horse g nus. R llin asse ts, th t th comm mul from th ass a d horse is part cularly pt to h e bars on t l gs accord to M Gosse i c rt in part f th Un ted States abo t n ne t of ten mul ha triped le s I nce saw a mul with ts l gs so m ch str ped that any m ght h e tho ght that t w s a hybrid b and M W C Mart in h e cell t tre tise n th h rse has gi en figure f m l r mule I f col red d wings, wh ch I h e seen f h yb d bet en th ass and zebra, th l g w re m l m re plainly barred than the rest f th bod and n one f th m th re was a d bl l ld tripe In Lord M rt n fam us hyl rid from ch tn t mare and m l quagga, tl hybrid and en th p re ll spn g bseq tly prod ced from th sam mare b black Arab an w re mu h m plainly b red across th l gs than ev n the pure q agga. Lastl and this an the m t remarkabl case, hybrid has bee figured by D Gray (and h nf rms m tl t he kn w f a second case) from th ass and th h mi and tl hybrid, th gh th ass ly occasi ally has tripe ts l g and tl h m s has and has t n sl uld tripe n rth less had all fou leg barred and had

three short shoulder stripes like those on the dun Devonshire and Welsh ponies and even had some zebra like stripes on the sides of its face With respect to this last fact I was so convinced that not even a stripe of colour appears from what is commonly called chance that I was led solely from the occurrence of the face stripes on this hybrid from the ass and hemionus to ask Colonel Poole whether such face stripes ever occurred in the eminently striped Kattywar breed of horses and was as we have seen answered in the affirmative

What now are we to say to these several facts? We see several distinct species of the horse genus becoming by simple variation striped on the legs like a zebra or striped on the shoulders like an ass In the horse we see this tendency strong whenever a dun tint appears—a tint which approaches to that of the general colouring of the other species of the genus The appearance of the stripes is not accompanied by any change of form or by any other new character We see this tendency to become striped most strongly displayed in hybrids from between several of the most distinct species Now observe the case of the several breeds of pigeons they are descended from a pigeon (including two or three sub species or geographical races) of a bluish colour with certain bars and other marks and when any breed assumes by simple variation a bluish tint these bars and other marks invariably reappear but without any other change of form or character When the oldest and truest breeds of various colours are crossed we see a strong tendency for the blue tint and bars and marks to reappear in the mongrels I have stated that the most probable hypothesis to account for the reappearance of very ancient characters is—that there is a *tendency* in the young of each successive generation to produce the long lost character and that this tendency from unknown causes sometimes prevails And we have just seen that in several species of the horse genus the stripes are either plainer or appear more commonly in the young than in the old Call the breeds of pigeons, some of which have bred true for centuries, species and how exactly parallel is the case with that of the species of the horse genus! For myself I venture confidently to look back thousands on thousands of generation and I see an animal striped like a zebra but perhaps otherwise very differently constructed the common parent of our domestic horse (whether or not it be descended from one or more wild stocks) of the ass the hemionus, quagga, and zebra

He who believes that each equine species was independently created will I presume assert that each species has been created with a tendency to vary both under nature and under domestication in this particular manner so as often to become striped like the other species of the genus and that each has been created with a strong tendency when crossed with species inhabiting distant quarters of the world to produce hybrids resembling in their stripes not their own parents, but other species of the genus To admit this view is, as it seems to me to reject a real for an unreal or at least for an unknown cause. It makes the works of God a mere mockery and deception I would almost as soon believe with the old and ignorant cosmogonists that fossil shells had never lived but had been created in stone so as to mock the shells living on the sea shore

Summary—Our ignorance of the laws of variation is profound Not in one case out of a hundred can we pretend to assign any reason why this or that part has varied But when

eties of the same species and the greater differences between species of the same genus. Changed conditions generally induce mere fluctuating variability but sometimes they cause direct and definite effects and these may become strongly marked in the course of time though we have not sufficient evidence on this head Habit in producing constitutional peculiarities and use in strengthening and disuse in weakening and diminishing organs appear in many cases to have been potent in their effects Homologous parts tend to vary in the same manner and homologous parts tend to cohere Modifications in hard parts and in external parts sometimes affect softer and internal parts When one part is largely developed perhaps it tends to draw nourishment from the adjoining parts and every part of the structure which can be saved without detriment will be saved Changes of structure at an early age may affect parts subsequently developed and many cases of correlated variation the nature of which we are unable to understand undoubtedly occur Multiple parts are variable in number and in structure perhaps arising from such parts not having been closely specialised for any particular function so that

their modifications have not been closely checked by natural selection. It follows probably from this same cause, that organic beings low in the scale are more variable than those standing higher in the scale, and which have their whole organisation more specialised. Rudimentary organs, from being useless, are not regulated by natural selection, and hence are variable. Specific characters—that is, the characters which have come to differ since the several species of the same genus branched off from a common parent—are more variable than generic characters, or those which have long been inherited, and have not differed from this same period. In these remarks we have referred to special parts or organs being still variable because they have recently varied and thus come to differ; but we have also seen in the second chapter that the same principle applies to the whole individual; for in a district where many species of a genus are found—that is, where there has been much former variation and differentiation, or where the manufactory of new specific forms has been actively at work—in that district and amongst these species, we now find, on an average, most varieties. Secondary sexual characters are highly variable, and such characters differ much in the species of the same group. Variability in the same parts of the organisation has generally been taken advantage of in giving secondary sexual differences to the two sexes of the same species, and specific differences to the several species of the same genus. Any part or organ developed to an extraordinary size or in an extraordinary manner, in comparison with the same part or organ in the allied

traord

genus

it shou... — —

er degree than other parts; for variation is a long-continued and slow process, and natural selection will in such cases not as yet have had time to overcome the tendency to further variability and to reversion to a less modified state. But when a species with any extraordinarily developed organ has become the parent of many modified descendants—which on our view must be a very slow process, requiring a long lapse of time—in this case, natural selection has succeeded in giving a fixed character to the organ, in however extraordinary a manner it may have been developed. Species inheriting nearly the same constitution from a common parent, and exposed to similar influences, naturally tend to present analogous variations, or these same species may occasionally revert to some of the characters of their ancient progenitors. Although new and important modifications may not arise from reversion and analogous variation, such modifications will add to the beautiful and harmonious diversity of nature.

Whatever the cause may be of each slight difference between the offspring and their parents—and a cause for each must exist—we have reason to believe that it is the steady accumulation of beneficial differences which has given rise to all the more important modifications of structure in relation to the habits of each species.

CHAPTER VI

DIFFICULTIES OF THE THEORY

Long before the reader has arrived at this part of my work a crowd of difficulties will have occurred to him Some of them are so serious that to this day I can hardly reflect on them without being in some degree staggered but to the best of my judgment the greater number are only apparent and those that are real are not I think fatal to the theory

These difficulties and objections may be classed under the following heads —First why if species have descended from other species by fine gradations do we not everywhere see innumerable transitional forms? Why is not all nature in confusion instead of the species being as we see them well defined?

Secondly is it possible that an animal having for instance the structure and habits of a bat, could have been formed by the modification of some other animal with widely different habits and structure? Can we believe that natural selection could produce on the one hand an organ of trifling importance such as the tail of a giraffe which serves as a fly flapper and *on the other hand an organ so wonderful as* h ?

cells and which has practically anticipated the discoveries of profound mathematicians?

Fourthly how can we account for species when crossed being sterile and producing sterile offspring whereas when varieties are crossed their fertility is unimpaired?

The two first heads will here be discussed some miscellaneous objections in the following chapter Instinct and Hybridism in the two succeeding chapters

On the Absence or Rarity of Transitional Varieties —As natural selection acts solely by the preservation of profitable modifications each new form will tend in a fully stocked country to take the place of and finally to exterminate its own less improved parent form and other less favoured *forms with which* it comes into competition Thus extinction and natural selection go hand in hand Hence if we look at each species as descended from some unknown form both the parent and all the *transitional* varieties will generally have been exterminated by the very process of the formation and perfection of the new form

But, as by this theory innumerable transitional forms must have existed why do we not find them embedded in countless numbers in the crust of the earth? It will be more convenient to discuss this question in the chapter on the Imperfection of the Geological Record and I will here only state that I believe the answer mainly lies in the record being incomparably less perfect than is generally supposed The crust of the earth is a vast museum but the natural collections have been imperfectly made and only at long interval of time

But it may be urged that when several closely allied species inhabit the same territory we surely ought to find at the present time many transitional forms Let us take a simple case in travelling from north to south over a continent we generally meet at successive intervals with closely allied or representative species evidently filling nearly the same place in the natural economy of the land These *representative species often* meet and interlock and as the one becomes rarer and rarer the other becomes more and more frequent, till the one replaces the other But if we compare these species where they intermingle they

each By my theory these allied species are descended from a common parent and during the process of modification each has become adapted to the conditions of life of its own region and has supplanted and exterminated its original parent form and all the transitional varieties between its past and present states Hence we ought not to expect at the present time to meet with numerous transitional varieties in each region though they must have existed there and may be embedded there in a fossil condition But in the intermediate region having intermediate conditions of life *why do we not now find closely linking intermediate* varieties? This difficulty for a long time quite confounded me But I think it can be in large part explained

In the first place we should be extremely cautious in inferring because an area is now

y of escaping from th d fficult f I be b that many pe fectly d fi ed pecies ha been f med t ictly co t areas Ill gh I d t d ubt th t tl f rm ly brok n cond t f areas n w co t us, has pla ed an impo tant part in tl f mati n f new species, m re especi lly w th freely-crossing and wand ri g an mals.

I looks t speci as tl y are w distrib ted wid area, we g rally find them tol rably um ro la g t rri tory th becom g somewl t abruptly ra and rare tl confi es, and finally d sappearing. H e tl n t l t rr t ry betwee t represe tati e pec g rally narrow compariso th tl t rrito y prope to each. W see th sam fact asce d g m tains, and som tim t q t rem kabl how abruptl as Alpl d Cand ll ha bserved comm alp peci d sappear Tl sam fact l as bee t ced by E. F rbe in sound g tl l pths f tl se w tl the dredg T those wh look t l m t and tl physical cond t ns of lif as tl all important elem ts f distrib t these facts ght t ause rprise as cl mat nd h ght d ptl gradual y insens l ly B t B w bear m nd that almost ry pecies, n in ts m tropolis, w ld ncrease imm nsely m bers, w re t n t f th compet g pec es that arly all th pre se as prey f r th rs short, th t ach gani b g th d ectly nd rectly related in the most impo tant mann t th ganic be gs.— see that th ang f th nh b tants of y cou tr l an l ly d se d se d ly har gi g g h ic l cond tio s, t t n larg part the p sence f the pec es, on

blend g ne t anoth by sensible grad tions, the an of any on pec es, depend g as t does on th range of th rs, w ll t nd to be sharply defi ed Moreo er each pecies o the co fi s f ts ran e where t exists in lessened numl ers, will d ri g fl ctuat on n the num l f ts m f ts prey o in the n

As all ed r repr n tati e pecies wh n in l b ting a co t nu s are a e g nerally distrib ted in cl a mann that ch has a w d range, w th a compa ly n ow neutral t rr t ry between them in which th y become tl dd nly rarer and rarer then, as v ri t e d t esse t lly d ff r from peci s, th sam rul will probabl pply t both a d if we take a vary ng peci inhab ti g a y larg area, we hall h to ad pt two vari t to t o larg areas, and a third ari ty to a narrow int medi t zo e Th int med te

tween w ll marked vari t es n the g s

et es t rmed te b twee tw the forms occ th y are m ch ra m rically that ll f ms which th y co ect. N w f we may trust th se fact and f rences, and conclud

can und rstand why t med t ari t l ld n t end re f y l periods — hy as g ral rul th y l ld be te m nated and disappear soo tl an the f m wl h th y riginally linked t g tl r

F any f m xi ting l sse numb rs w ll as lready m rked un a gre ter chance f be t min ted than e existing n larg mb and this part ular case th nt rmed t f m w ld be min ntly l ble t th nroad of cl sely ll ed f rms ex

tic re pposed to b con rted and pe fected into two disti t peci s, th t o wh ch ist larg mbers, from inhab t g larg r areas, w ll l great ad antag o r th intermed t ari ty wl cl ex ts n small r mbers in a arrow and int mediate zone.

For forms existing in larger numbers will have a better chance within any given period of presenting further favourable variations for natural selection to seize on than will the rarer forms which exist in lesser numbers Hence the more common form in the race for life will tend to beat and supplant the less common forms for these will be more slowly modified and improved It is the same principle which as I believe accounts for the common species in each country as shown in the second chapter presenting on an average a greater number of well marked varieties than do the rarer species I may illustrate what I mean by supposing three varieties of sheep to be kept one adapted to an extensive mountainous region a second to a comparatively narrow hilly tract and a third to the wide plains at the base and that the inhabitants are all trying with equal steadiness and skill to improve their stocks by selection the chances in this case will be strongly in favour of the great holders on the mountains or on the plains improving their breeds more quickly than the small holders on the intermediate narrow hilly tract and consequently the improved mountain or plain breed will soon take the place of the less improved hill breed and thus the two breeds which originally existed in greater numbers will come into close contact with each other without the interposition of the supplanted intermediate hill variety

To sum up I believe that species come to be tolerably well defined objects and do not at any one period present an inextricable chaos of varying and intermediate links first because new varieties are very slowly formed for variation is a slow process and natural selection can do nothing until favourable individual differences or variations occur and until a place in the natural polity of the country can be better filled by some modification of some one or more of its inhabitants And such new places will depend on slow changes of climate or on the occasional immigration of new inhabitants and probably in a still more important degree on some of the old inhabitants becoming slowly modified with the new forms thus produced and the old ones acting and reacting on each other So that in any one region and at any one time we ought to see only a few species presenting slight modifications of structure in some degree permanent and this assuredly we do see

Secondly areas now continuous must often have existed within the recent period as isolated portions in which many forms more especially amongst the classes which unite for each birth and wander much may have separately been rendered sufficiently distinct to rank as representative species In this case intermediate varieties between the several representative species and their common parent must formerly have existed within each isolated portion of the land but these links during the process of natural selection will have been supplanted and exterminated so that they will no longer be found in a living state

Thirdly when two or more varieties have been formed in different portions of a strictly continuous area intermediate varieties will it is probable at first have been formed in the intermediate zones but they will generally have had a short duration For these intermediate varieties will from reasons already assigned (namely from what we know of the actual distribution of closely allied or representative species and likewise of acknowledged varieties) exist in the intermediate zones in lesser numbers than the varieties which they tend to connect From this cause alone the intermediate varieties will be liable to accidental extermination and during the process of further modification through natural selection they will almost certainly be beaten and supplanted by the forms which they connect for these from existing in greater numbers will in the aggregate present more varieties and thus be further improved through natural selection and gain further advantages

Lastly looking not to any one time but to all time if my theory be true numberless intermediate varieties linking closely together all the species of the same group must assuredly have existed but the very process of natural selection constantly tends as has been so often remarked to exterminate the parent forms and the intermediate links Consequently evidence of their former existence could be found only amongst fossil remains which are preserved as we shall attempt to show in a future chapter in an extremely imperfect and intermittent record

On the Origin and Transitions of Organic Beings with peculiar Habits and Structure —It has been asked by the opponents of such views as I hold how for instance could a land carnivorous animal have been converted into one with aquatic habits for how could the animal in its transitional state have subsisted It would be easy to show that there now exist carnivorous

animals presenting close interm d ate grad s from tr tly t rre trial t q t c hab ts and as ach sts by a tr ggl f r lif t i clear that acl m t b well ad pted to ts place in nature Look t th *Mustela rsn n of N th Am a*, wh ch has wel bed feet, and wh ch resembl an ott its f r short l g and f rm f tail. D n th mm r th mal di es f and preys fi h, b t d ng the lo g wi te t l e tl fro en w t rs, a d preys, lik tl pole-cat o m and land mals If d ff re t case had bee tak n, and t had been asked how an insect ro quadruped co ld poss bly b been co erted i to fly ing b t, th qu t ld h b n far more difficult to an Y t I th nk u h d ffi lties ha e littl w ght

H re, as oth r occas ns I h und a h y disad antag f t f th many trik g case wi ch I h e collected I can nl gi n tw tance f t ans t al hab ts and tru t all ed pec d f d fied h l ts, tl r co tant occas al, in the sam pec s. A d t seems to m that noth g l ss than l g h t f h cas ffi t to l ssc th d ffi lty in any par ticular case lik th t f th b t.

Look t tl family f sq rrels here we h th fi est g ad t from an mal w th th ir tails ly l gl tly fl tt ed and f om *thers*, as S J R hardso l as marked w th th post rio part f th bod rather w d and th tl k tl flanks th f ll t th so-c lled fl g sq rrels and fly g squir l h th l mb and th base f th tail t d by broad panse f kin wh ch serves as parach t d ll w th m to glid thro gl tl t ast h g distance from tree to tree W ann t d bt that ach truct re is f use t ach k d f sq rrel i its co try l y nabl g t t se pe b rd beasts f prey to collect food m q ckly as tl re m reaso to bel to l sse th dang from occas nal falls. B t t doe t follow from this fact that th tructure f ach sq rrel th be t th t t is poss bl t co cei nd all possibl co d ti ns. Let the l mat and g tat chang l t tl com peting rod ts w beasts f prey mmi gr t kl cs becom mod f d d all anal gy w ld l ad to bel B t some I least f tl sq rrels w ld d crease m be becom t rm nated nless tl y also becom mod fied and mpro ed tructure correspond g man Tl ref re I can see no difficulty more pecially nd r changin

cond ti ns f lif in the continued preserva tion f indi d als with f ll r and f ller flank m mbr n each modificat n bein us ful

flying lemu wh ch forme ly was anked am g t b ts, b t is n w bel d t belo g to th Insect a. An t em ly w de flank m mb ane tretches from the co ers f the j w to th tail and in lud s the l mbs with th

w th the lo nsect

culty in ppo ing that ch l nks f m ly xisted and that acl w d el ped n the sam manne as w th the l ss pe fectly gl ding q rrels *each grade of tru ture ha ng been* us f l t its poss sso No an I see any i pe abl d fficulty in f rtl r b lie g th t

tain b ts in wh ch th w g memb ane xtends *from th top f th shoulder to the tail and* n l des th hind l gs, w p h p see trace f appar tus riginally fitted for gliding *thro gh th ther than for fl ght.*

If ab ut d n g n ra f birds were to b com e tin t, wh w ld ha e v tured to rm se that b rd m ght h ex t d which

lik the pe g in as sails, lik tl t ch and fun t ally f r n purpose lik the Apt ryx Y t the truct re f ach f these birds is good f t, und th co d ti ns f life to which it s xposed f each has to li e by a str ggl but t is n t ecessarily the be t poss ble under all poss bl co d ti s. It must n t b inf rred from th se remarks that any f the grad f wing tru ture h re all ded to which pe h ps m y all be th re lt of dis se ind cat th t p by which b rds actually acq ired their perfect pow f fl ght b t th y serve to sh w what di rsified m ans f transiti n are t l ast poss ble

See g th t f w m mbers f ch wate breathing classes as th Cru tace and M llus ca are adapted to liv on th land and seeing

that we have flying birds and mammals flying

lightly rising and turning by the aid of their fluttering fins might have been modified into perfectly winged animals If this had been effected who would have ever imagined that *in an early transitional* state they had been the inhabitants of the open ocean and had used their incipient organs of flight exclusively as far as we know to escape being devoured by other fish?

When we see any structure highly perfected for any particular habit, as the wings of a bird for flight we should bear in mind that animals displaying early transitional grades of the structure will seldom have survived to the present day for they will have been supplanted by *their successors* which were gradually rendered more perfect through natural selection Furthermore we may conclude that transitional states between structures fitted for very different habits of life will rarely have been developed at an early period in great numbers and under many subordinate forms Thus to return to our imaginary illustration of the flying fish it does not seem probable that fishes capable of true flight would have been

forms

ways

organs of flight had come to a high stage of perfection so as to have given them a decided

existed in lesser numbers than in the case of species with fully developed structures

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clared yet as I can assert, not only from my own observation but from those of the accurate Azara, in certain large districts it does not climb trees, and it makes its nest in holes in banks[1] In certain other districts, however the same woodpecker as Mr Hudson states *frequents trees and bores holes in* the trunk for its nest. I may mention as another illustration *of the varied habits of this genus,* that a

Mexican Colaptes has been described by De Saussure as boring h les into hard wood in order to lay up a store of acorns.

Petrels are the most erial and oceanic of birds, but in th qui t sounds f Tierra del Fuego, the *P ffi uria berardi* in its ge ral habits, in its astonishing pow r f d ing in its manner of swimming and of flying wh n made to take flight, would b mistak n by any ne for an auk or grebe ertheless t is essentially petrel, b t w th many parts of ts

the deeply scooped membrane between the toes shows that tru ture has begun to ch nge.

He who belie es in separate and innumerable acts f creation m y say that in these cases it has plea ed th Creato to cause a being of on t pe t take the place f ne belo g ing to an ther type b t this seems to me nly re stating th fact in d gnified langu ge He who beli es n th struggl for xistence and in the princ ple of n tural select n will acknowledge th t e ry organ c bein is con stantly nd a ouring to n rease in mbers and th t if any one bein v ries r so l ttle e ther hab ts r truct re, and th s g ins an advantage o r some otl er inhabitant f the same country it w ll se n th place f th t

the thrush family bsists by d g— ing its wings und wate and gra p g to es ith ts feet. All th m mbers of th great order of h men pt rous insects are t rrestrial, xcepting th g l roctotrupes, whi h S r John Lubbock has discovered to be q t in its hab ts t oft nt rs the wat and d es about by th se not f ts l gs but of ts wings, and remains as lo g as f ur h rs be th th surface y t t xh b ts n mod ficat n in structure in accordance with ts ab mal hab ts.

H who beli es that ach bein l as been created as we w see t, m t occas ally ha e f lt rprise wh h has m t w th an animal ha ing hab ts and tru t re not in agreement. Wh t can be plain than th t the webbed feet of ducks and geese re f rmed f swimming Y t th re are upland geese with ebbed feet hich rarely go n ar th w te and no on cept A d bon has seen th frigate-bird, hich has all ts f ur toe webbed, alight n the surface of th ocean. O th th hand, grebes and coots are min tly aqu tic, although their toes are nly bord red b m m brane. What seem plain than th t th long toes, not f rnished w th m mbran f the Grallatores are f rmed for walking er swamps and floating plants —th w t r hen and landrail are m mbers of this rd y t th first is nearly as aq atic as th coot, and th second nearly as t rrestrial as th q l or partridge. In such cases, and many th rs could be g n, hab ts ha changed w th t a corresponding change of truct re Th w bbed feet of th pland goose may be said to have become almost rudimentary in functi n, though not in structure. In the frigate-bird,

birds w th webbed feet, li ing on the d y land and rarely al ght g n the wat that th re sh uld be lo toed corncrak s, living in mead ws t ad f n wamp tl t th re should be woodpeck rs where hardly a tree grow th t th re sh uld be di ing thrushes and d ing H men pt ra, and petrels w th the hab ts of auks.

Organs of extreme Perfection and Complication

T suppose th t th ey w th all ts inimitable contri ance f adjusting th focus to d ff nt d tances, f r adm ttin diff t m unt of light and fo th correcti f sph cal and chromat c aberrati co ld hav been f med by natural select seems, I freely confess, abs rd in th e h ghest d gree When t was first said th t th un tood t ll and the w ld turned ro d th comm n sense of mankind declared the doctr e false but th ld saying f *V x popul x Dei*, as e ry philosopher knows, cann t b tru ted in scie ce Reason t lls me, th t if numero grad ti ns from a simpl and imperfect ye to complex and perfect can be shown to exist, ach grade b ing

select n, tho gh ins perable by our imagina tion, sh ld t be considered as subv rs v of the theory H w a rve comes to be sensitiv to light, hardly concerns us more than how

that we have flying birds and mammals flying insects of the most diversified types and formerly had flying reptiles it is conceivable that flying fish which now glide far through the air slightly rising and turning by the aid of their fluttering fins might have been modified into perfectly winged animals If this had been effected who would have ever imagined that in an early transitional state they had been the inhabitants of the open ocean and had used their incipient organs of flight exclusively as far as we know to escape being devoured by other fish?

When we see any structure highly perfected for any particular habit as the wings of a bird for flight we should bear in mind that animals displaying early transitional grades of the structure will seldom have survived to the present day for they will have been supplanted by their successors which were gradually rendered more perfect through natural selection Furthermore we may conclude that transitional states between structures fitted for very different habits of life will rarely have been developed at an early period in great numbers and under many subordinate forms Thus to return to our imaginary illustration of the flying fish it does not seem probable that fishes capable of true flight would have been developed under many subordinate forms for taking prey of many kinds in many ways on the land and in the water until their organs of flight had come to a high stage of perfection so as to have given them a decided advantage over other animals in the battle for life Hence the chance of discovering species with transitional grades of structure in a fossil condition will always be less from their having existed in lesser numbers than in the case of species with fully developed structures

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F em the *P ffin ria bera di*, in ts g n ral hab ts, in ts astonishing power f d g in ts mann of swimming a d of flying wh made to take fl ght, w ld be m taken by any e for an uk o a grebe rtheless it is essen tially a petrel b t w th many parts of ts organisatio prof dly modified n l t n to ts w hab ts f life wh reas th wood peck f La Pl ta has had its struct re nly lightly modified In th cas f th w ter ouzel, the acut t l server by xam ing its d ad body w ld n h su pected its b- aquat c hab ts y t th s b rd wl ch all ed to the thrush f mily bsists by d g— ing wings d r w t r and grasp g st es with ts fect. All the m mbers f th great order f hym pt ro insects are t rrestrial,

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Organs of extreme Perfection and Complication

T suppose th t tl e eye with all its inimit ble co tri an f adjusting tl foc s to d ff r nt d ta es, for dm tting diff t m unts of l ght, d fo th correct f ph cal and chrom t c b t co ld h v been f med by n t l select seem I freely co fess, b rd tl l ghest d gree When t was first said tl t th un tood till d the w ld turned ro d the commo sense of mankind decl red th doctrin f lse but th ld y g of *l pop l ox Dei* as ery philosopher kn ws, ann t be trusted in scie ce. R ason t lls m th t if n m rous grad ti ns from a s mple and mperfect ey to ne complex and pe fect can b sh wn to exist ach grad be ng usef l to its possessor as is certainly th case if furthe th y and the ria- tions b nh rited as is lik wise certainly th cas and if such variations h uld be usef l to any mal d chang ng co d t ons f lif th n th d fficulty f b l e i g th t a perfect an l compl ey co ld b f rmed by natural select th gh pe able by our imagina- ti h uld n t b cons de ed as sub ers of the theo y H w a n rve comes to be ns ti to light, hardly concerns us more than how

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d w h rm t, but d tit te f any th

tio of epid rmic cells, l ing in sa k hk f ld of th skin and th treo bod f med from mbry m b-c taneous tissu To ar ri h w t j t co lu regard th f rmatio f th th all ts m l lous y t t absol t ly perfect ch ract rs, t is indispensabl th t th reaso h M co q th magnat b t I h f lt th difficulty far too keenl t b rprised t th rs hes tat ing t t d th p in pl f t al selecti t so tartling l gth.

It is scarcel poss bl t d comp ri g th with t l scope W kn w th t this instrum t has bee perfected b th l g co tin ed ff rts f th h hest h man t l l cts and w t rally inf th t th l as bee f rmed b som wh t an l g process B t m y t this inf re ce b pres mpt Ha an right to assum that th Cre t w ks b int llect al pow rs lik th se f man If m t compare th t an pt cal nstrument ght in m g natio t tak thick la f tran pare t t s. w th pace filled with fl id an l with rv sens t to l ght be th, and th ppose rs p rt f this la t be co t all hang l l m d ns t so as to separ t into la rs f dif f re t d ns t and thickn sses, placed t dif f r t distances from ach M and w th th rfaces of ach la lo ly hang g f m F rth must ppose that th is pow represe ted b nat ral selectio th rv l f th fittest al inte tl w t hing ach l gl t alt tio tl tran pare t l y rs and caref ll y preserv g each wi h d ned circ m tances, w any d ree, tend t prod ce d t t mag W must ppose ach w tat f tl in trum t t be m lt pl ed l th in lh ach t be preserved t l bett prod ced, and tl tl M ones to be all destro ed In li g bod s, an tio ll se tl l l t alt tio s, g ra t w ll m lt pl tl m alm t finit l and

t beli that h pticalinstrum might th be f rm d as perio to of

glass, as th w ks f the Creator are to those f man

Modes of Transition

If t could b d m trated that any com pl x organ sted wh h co ld not poss bly

ciall if w look t m ch solated species, ro nd

nally fo med t a rem t period since wh h ll th m m mbers f the class h e been d loped d in rd to disco e the rly tran tio al grad thro h which th o g n has passed w h uld ha to look to y anc t ance tral f rms, lo g nce becom xt t.

W h ld b xtrem ly ca t ou in con l d g that an rgan co ld n t h e been fo med b tran t al gradat ns f some ki d N m ro case co ld be gi n m gst th l w animals f th sam rgan perf rm g at th sam t m wh ll d tinct fun tions th s in th l rv f th drag n fly and n th fi h Col tis th l m tary canal re pires, d ests and e cret s. In th Hydra, the an mal m y be t rned in d t, and th te io rface will th d t and th tomach respire In ch case n t al select n m ht pec l se f any ad antag w re th gained th wh l p t f an an which had pre iously perf med t f t ns, f f t n al and tl s b inse bl t p greatly chang ts n t re M plants are kn wn wh ch regularly pro d ce th sam t me diff rently constru ted fl w rs and if ch plants w re t prod ce n ki d l gre t ha g w ld b ffected with comparat dde ess th haract f tl pec es It s, h probabl that tl t sorts f fl w rs b rn by th sam pla t w re riginall diff re tiated by fin ly grad ted t ps, which m y till b f llowed in som f w cases.

Ag tw distinct rgans, o th sam gan und t rs d ff rent f rms, ma sim l taneo l perf rm in th sam ind d al th sam functio and this is an tremely impo tant m ans f trans t to g o instance —tl re are fish with gills b anchiæ th t breath th air dissol ed in the w te t th

life itself originated but I may remark that, as some of the lowest organisms in which nerves cannot be detected are capable of perceiving light it does not seem impossible that certain sensitive elements in their sarcode should become aggregated and developed into nerves endowed with this special sensibility

In searching for the gradations through which an organ in any species has been perfected we ought to look exclusively to its lineal progenitors but this is scarcely ever possible and we are forced to look to other species and genera of the same group that is to the collateral descendants from the same parent form in order to see what gradations are possible and for the chance of some gradations having been transmitted in an unaltered or little altered condition But the state of the same organ in distinct classes may incidentally throw light on the steps by which it has been perfected

The simplest organ which can be called an eye consists of an optic nerve surrounded by pigment-cells and covered by translucent skin but without any lens or other refractive body We may however according to M Jourdain descend even a step lower and find aggregates of pigment-cells apparently serving as organs of vision without any nerves and resting merely on sarcodic tissue Eyes of the above simple nature are not capable of distinct vision and serve only to distinguish light from darkness In certain star fishes small depressions in the layer of pigment which surrounds the nerve are filled as described by the author just quoted with transparent gelatinous matter projecting with a convex surface like the cornea in the higher animals He suggests that this serves not to form an image but only to concentrate the luminous rays and render their perception more easy In this concentration of the rays we gain the first and by far the most important step towards the formation of a true picture forming eye for we have only to place the naked extremity of the optic nerve which in some of the lower animals lies deeply buried in the body and in some near the surface at the right distance from the concentrating apparatus and an image will be formed on it

In the great class of the Articulata we may start from an optic nerve simply coated with

contr va

the numerous facets on the cornea of their great compound eyes form true lenses, and that the cones include curiously modified nervous filaments But these organs in the Articulata are so much diversified that Müller formerly made three main classes with seven subdivisions besides a fourth main class of aggregated simple eyes

When we reflect on these facts, here given much too briefly with respect to the wide, diversified and graduated range of structure in the eyes of the lower animals and when we bear in mind how small the number of all living forms must be in comparison with those which have become extinct the difficulty ceases to be very great in believing that natural selection may have converted the simple apparatus of an optic nerve coated with pigment and invested by transparent membrane into an optical instrument as perfect as is possessed by any member of the articulate class

He who will go thus far ought not to hesitate to go one step further if he finds on finishing this volume that large bodies of facts, otherwise inexplicable can be explained by the theory of modification through natural selection he ought to admit that a structure even as perfect as an eagle s eye might thus be formed although in this case he does not know the transitional states It has been objected that in order to modify the eye and still preserve it as a perfect instrument many changes would have to be effected simultaneously which it is assumed could not be done through natural selection but as I have attempted to show in my work on the variation of domestic animals it is not necessary to suppose that the modifications were all simultaneous if they were extremely slight and gradual Different kinds of modification would also serve for the same general purpose as Mr Wallace has remarked if a lens has too short or too long a focus it may be amended either by an alteration of curvature or an alteration of density if the curvature be irregular and the rays do not converge to a point then any increased regularity of curvature will be an improvement So the contraction of the iris and the muscular movements of the eye are neither of them essential to vision but only improvements which might have been added and perfected at any stage of the construction of the instrument Within the highest division of the animal kingdom namely the Vertebrata we can start from an eye so simple that it consists, as in the lancelet, of a little sack of transparent skin furnished with a nerve and

ing nstance —
th h rns of tag becom m re and m re branched and the plumes of some bird b com m re finely de l ped as they grow lde Prof Cope tate th t th teeth f c tam Lizards change m cl in h pe w th advancing y ars w th crustacean n t nly many trivial b t some mportant parts ass m n char act r as recorded by F tz Mull afte ma turity In all ch case —and many co ld be gi n,—if the age fo prod ct o we e retarded th characte f th species, at l ast in ts adult tate, w uld b modified no is t im prob bl that th previo s and earlie tages

can f rm pin but if this has occurred, t is probabl th t th d ff rences between th y ung and th mature and betwee th ma ture and th ld w re primordially acquired by graduated teps.

Spec al Diffi ult es of the Theory f Natu al S lect n

Alth gh w must be trem ly ca ti s in co cl d g th t any gan co ld t h ve been produced by success e, mall tran t nal grad t ns, y t und btedly se ious cases f difficulty occu

O f th most se io s that f n uter in sects, wh ch are lte d ff re tly constru ted from th th mal f rt l f mal b t th ase ll b tre ted f th n t ch pt r Th lectr gans of fi hes ff th cas f spec al diff cult f t is mposs bl t con ce b wh t tep th se w drous gans ha bee prod ced It t thus not rprising, f d not kn w f wh t use th y are. In th G m t and t rped th y no d bt serv a. f rf l mea f d f ce and per

that t can hardly be f y se f th ab p rposes M reo in th ray b sides th S t ref rred to, th re s, as D R. M D

that th re ex t bet ee th gans an l

dinary muscl a close analogy in intim te structure in the d tributi n f the n rves, and i the manner in wh ch th y are acted on by a iou re gents. It sho ld also be e pe c ally bserved th t mu cular contract n s ac compan ed b an electr cal discharge and as Dr Radcliffe insists, in the electrical appar f h t rmed d ring re t, the e w uld

but as we are

organs, and as we know noth ng about the hab ts and truct re f the pro nit rs f th exist g lectric fishes, it would b e tremely bold to maintain that no s rv ceable transi ti re poss bl by which these organs m ht

in also t a

re w dely r mot in th ir ffiniti s. Wh the sam gan f d in se l members f th sam class especially if in m mbers ha n v ry d ff rent h b ts f life, w m y g er lly attr b te ts prese ce to nh rita ce from a common an t and ts absence in som f th m mbers to loss through dis se o n t al selecti n. So th t, if th electric organs had

th ir mod fied d sce d nts h n l t. But wh n w look t th bject m l selv n find in th se r l fishes pro ided w th lectri rgans, th t th are sit ted n diff re t parts f th body —th t th diff cr structi n, as th ar an m nt f th p l t s, and according to P cini, n th p ocess or m an b wh ch th lectri ty is e ted— and lastl n b g pplied w th es proceeding from diff re t urces, and th h ps th m t mp rtant f all th diff rences. H nce in th se al fishes f rnished w th lec tr gan th se cann t b co d ed as h m log s, b t nly as analo s in f ti n. C nseq tly th e n aso to p pose th t th y h e b n nh rited from a common pro enitor f had th been th case

same time that they breathe free air in their swimbladders, this latter organ being divided by highly vascular partitions and having a ductus pneumaticus for the supply of air. To give another instance from the vegetable kingdom: plants climb by three distinct means, by spirally twining, by clasping a support with their sensitive tendrils, and by the emission of aerial rootlets; these three means are usually found in distinct groups, but some few species exhibit two of the means, or even all three, combined in the same individual. In all such cases one of the two organs might readily be modified and perfected so as to perform all the work, being aided during the progress of modification by the other organ; and then this other organ might be modified for some other and quite distinct purpose, or be wholly obliterated.

The illustration of the swimbladder in fishes is a good one, because it shows us clearly the highly important fact that an organ originally constructed for one purpose, namely flotation, may be converted into one for a widely different purpose, namely respiration. The swimbladder has also been worked in as an accessory to the auditory organs of certain fishes. All physiologists admit that the swimbladder is homologous, or "ideally similar" in position and structure with the lungs of the higher vertebrate animals: hence there is no reason to doubt that the swimbladder has actually been converted into lungs, or an organ used exclusively for respiration.

According to this view it may be inferred that all vertebrate animals with true lungs are descended by ordinary generation from an ancient and unknown prototype, which was furnished with a floating apparatus or swimbladder. We can thus, as I infer from Owen's interesting description of these parts, understand the strange fact that every particle of food and drink which we swallow has to pass over the orifice of the trachea, with some risk of falling into the lungs, notwithstanding the beautiful contrivance by which the glottis is closed. In the higher Vertebrata the branchiae have wholly disappeared—but in the embryo the slits on the sides of the neck and the loop-like course of the arteries still mark their former position. But it is conceivable that the now utterly lost branchiae might have been gradually worked in by natural selection for some distinct purpose: for instance, Landois has shown that the wings of insects are developed from the tracheae; it is therefore highly probable that in this great class organs which once served for respiration have been actually converted into organs for flight.

In considering transitions of organs, it is so important to bear in mind the probability of conversion from one function to another, that I will give another instance. Pedunculated cirripedes have two minute folds of skin, called by

surface of the body and of the sack, together with the small frena, serving for respiration. The Balanidae or sessile cirripedes, on the other hand, have no ovigerous frena, the eggs lying loose at the bottom of the sack, within the well-enclosed shell; but they have, in the same relative position with the frena, large, much-folded membranes, which freely communicate with the circulatory lacunae of the sack and body, and which have been considered by all naturalists to act as branchiae. Now I think no one will dispute that the ovigerous frena in the one family are strictly homologous with the branchiae of the other family; indeed, they graduate into each other. Therefore it need not be doubted that the two little folds of skin, which originally served as ovigerous frena, but which, likewise, very slightly aided in the act of respiration, have been gradually converted by natural selection into branchiae, simply through an increase in their size and the obliteration of their adhesive glands. If all pedunculated cirripedes had become extinct, and they have suffered far more extinction than have sessile cirripedes, who would ever have imagined that the branchiae in this latter family had originally existed as organs for preventing the ova from being washed out of the sack?

There is another possible mode of transition, namely, through the acceleration or retardation of the period of reproduction. This has lately been insisted on by Prof. Cope and others in the United States. It is now known that some animals are capable of reproduction at a very early age, before they have acquired their perfect characters; and if this power became thoroughly well developed in a species, it seems probable that the adult stage of development would sooner or later be lost; and in this case, especially if the larva differed much from the mature form, the character of the species would be greatly changed and degraded. Again, not a few animals, after arriving at maturity, go on changing in character during nearly their whole lives. With mammals, for instance, the

details. N w such diff rences are int llgible, and might en ha been expected, n th uppos tion that pecies belonging to distinct families had slowly becom ad pted t ll more and more t of w t and to breath the air F these species, from bel nging to d tinct families, w uld h diff red to cer tai xtent, and in accordance with th principle that th nature of ach ariation d pends on tw fact rs, viz., th nature f th organism and that of the urrounding conditions, their ariab lit assuredly would t have been exactl th same. Conseq tly natural selec tio w uld ha had diff rent materials ariations t wo k on, in rd to arr t th sam functional result and th structures thus acq red would alm t ecessarl have dif f red. On th hypothesis of separat acts of creatio th whol case remains unint lligible. This lin of argum t seems t ha had great w ight in leading Frits M lle to accept th view maintained b m in this lume.

Anoth distinguished zoolo t, th lat Professo Clapared has argued in th same manne and has arr ed t th sam result. H show that th re are parasitic mites (Acar idæ belo ing to distinct ub-famil es and families, which are furnished with hair-claspers. These organs must ha been indepe d ntly d loped, as th could not h been in h rited from common pro enito and in the se ral gro p tl re f rmed b th modifi cation of the fore l gs,—of th hind l gs,—of th maxillæ o lips,—and of ppendages n the und ad of th hind part of th bod

In th f re n cases, w see th sam end gained and th sam functio perf rmed, in beings not t all al remot l allied, by organ in pperance th gh not in dev lopment losel similar On th th hand, t is a commo rul thro gho t nature that th sam end ould be gained. som times in th case of closel related be ngs, b th most diversified means. H w dui rentl constructed is the feath red n of bird and th m mbrane-co red win of bat and till more so th four win of b tterfl th t win f l and th tw win s th th l tra of a beetle B al shells are mad to pe and sh t, b t on hat umbe of patterns is th hi ge constructed,—from th lo row of neatl interlocki teeth in N cula to th simple l ament of Mussel Seeds are disseminated b th ir min t ness,—b their capsule being con rted into light balloon-like

n tribous, as ... so as to ttract and be d ured b birds,—by h vin hooks and grapn ls f many kinds and serrated wns, so as to adh re to th fu of quadrupeds,—and b bein furnished w th wings and pl mes, as diff rent in shape as th y are l ga t in stru ture so as to be wafted by ry bree e. I will giv on the instance f r this subject of th sam nd bein gained by the m t div rsified m ans w ll deserves tt tion. Some th rs mai tain that organi be ings hav been f rmed in man w f r the sak of m re variety almost lik to in a sh p b t such a vi w of nature is in redible W th plants havin separated sex s, and w th those in which, th u h hermaphrodit the

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poll n grains, wh ch are light and incoh rent, being blown by th wind through m re cl nce to the tigma and this is th simpl t plan which can w ll be conce ed An almost eq ally simpl th gh ery diff re t, plan occurs in many plants in which mm trical fl we se cretes a f w drop of nectar and is conse quentl sited b insects and these carry the pollen from th anth rs to th tigma.

From this simpl ta w may pass thro h an in xh u tibl numbe f contri ances, all f th sam purpose and ffected in esse tially th sam mann b t entailing chan es in ery part of th fl w Th nectar may be st red in an u ly shaped receptacles, with th tamens and pistils modified in man w s, som times f rming trap-lik contri ances, and som times capabl f neatly adapted m m ts thro h irritabilit elasticity From such stru tures w may ad ance till w com t such case f traord nary ad ptation as that lately described by D Cr in th *C y ke* Th orchid has part f ts labell m low l p hollowed o t into a great b ck t into which drop of alm t pure w te contin all fall from tw secreting horns which tand abo t and h n th b ck t is half f ll, th w t rfl w by spo t n o ad Th basal part of th labell m tands th buck t, and is tself h llowed o t into a sort f chambe with tw lat ral ntrances within this chambe th re are curious fleshy rid es. The most in enious man, if h had n t w t essed what takes place, could ne ha imagined what purpose all these parts serve.

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body offer under our present state of ignorance a difficulty almost exactly parallel with that of the electric organs Other similar cases could be given for instance in plants the very curious contrivance of a mass of pollen grains borne on a foot stalk with an adhesive gland is apparently the same in *Orchis* and *Asclepias* —genera almost as remote as is possible amongst flowering plants but here again the parts are not homologous In all cases of beings far removed from each other in the scale of organisation which are furnished with similar and peculiar organs it will be found that although the general appearance and function of the organs may be the same yet fundamental differences between them can always be detected For instance the eyes of cephalopods or cuttle fish and of vertebrate animals appear wonderfully alike and in such widely sundered groups no part of this resemblance can ...

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back of a darkened chamber Beyond this superficial resemblance there is hardly any real similarity between the eyes of cuttle fish and vertebrates as may be seen by consulting Hensen s admirable memoir on these organs in the Cephalopoda It is impossible for me here to enter on details but I may specify a few of the points of difference The crystalline lens in the higher cuttle fish consists of two parts placed one behind the other like two lenses both having a very different structure and disposition to what occurs in the vertebrata The retina is wholly different with an actual inversion of the elemental parts, and with a large nervous ganglion included within the membranes of the eye. The relations of the muscles are as different as it is possible to conceive and so in other points Hence it is not a little difficult to decide how far even the same terms ought to be employed in describing the eyes of the Cephalopoda and Vertebrata It is, of course open to any one to deny that the eye in either case could have been developed through the natural selection of successive slight variations but if this be admitted in the one case it is clearly possible in the other and fundamental differences of structure in the visual organs of two groups might have been anticipated in accordance with this view of their manner of formation As two men have sometimes independently hit on the same invention so in the several foregoing cases it appears that natural selection working for the good of each being and taking advantage of all favourable variations, has produced similar organs as far as function is concerned in distinct organic beings, which owe none of their structure in common to inheritance from a common progenitor

Fritz Müller in order to test the conclusions arrived at in this volume has followed out with much care a nearly similar line of argument. Several families of crustaceans include a few species possessing an air breathing apparatus and fitted to live out of the water In two of these families which were more especially examined by Müller and which are nearly related to each other the species agree most closely in all important characters namely in their sense organs circulating system in the position of the tufts of hair within their complex stomachs, and lastly in the whole structure of the water breathing branchiæ even to the microscopical hooks by which they are cleansed Hence it might have been expected that in the few species belonging to both families which live on the land the equally important air breathing apparatus would have been the same for why should this one apparatus, given for the same purpose have been made to differ whilst all the other important organs were closely similar or rather identical?

Fritz Müller argues that this close similarity in so many points of structure must, in accordance with the views advanced by me be accounted for by inheritance from a common progenitor But as the vast majority of the species in the above two families, as well as most other crustaceans are aquatic in their habits it is improbable in the highest degree that their common progenitor should have been adapted for breathing air Müller was thus led carefully to examine the apparatus in the air breathing species and he found it to differ in each in several important points as in the position of the orifices in the manner in which they are opened and closed and in some accessory

tructio of th less well-fitted individuals,—I ha sometime f lt great d fficulty in unde r t tl rigin f rm ti n f pa t f

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col f ts ll st tn co hair f quadrupeds, wh h from be ng correlated tl co t t ti al d ff re ce fn m d t rm ll ttacks f sects, m gl t assuredly be acted l t ral select o The tail of th g aff looks lik an artifi all con tructed fly flap pe and t seem t first m credil le th t thus co ld f bee ad pted f ts prese t purpose by ccess l ght mod

Am ca bsol t ly d pe nl tl r po r f resisting th ttacks f insects so th t nd d uals l ich co ld t anv m ns d f l th m sel from tl ese all m s, w ld b bl t g int past re and thus gai a gre t d ant g It is t that th lar j ad ruped are actually d tro ed (cept n som rare case) b fl es, b t tl are ssantl harassed and tl tre gtl red ced so tl t th y re m re bj ct t disease t so w ll abled m coming d th t se rcl f food t sc pe from beasts of prey

Organs now f tril g mportance l p ably m som ase bee f l gl mportai ce t an arl prog nit and aft h g been lo l pe fected l f m pe od h bee transm tted l xistin spec arl th sam tat alti gl w l l bt se b t an act all j n d t ns tl ir truct re w ld of co rse h bee checked by nat al selection. Seeing l w mpo tant an gan of locom tio th tail is m most q tic animals, t g ral prese ce and se f m y purpose m so mai land an mals, l ch n ll l g modified w mbladd rs b t thei aq t gin, m y pe hap be thus ac co ted f A w ll-d loped tail ha ing been f med m an aquati animal, it might bse- q tly com to be w ked in f all sorts of p rposes,—a fly flappe an rgan of prehen

o as an d n tu m as m the case of th d g th ugh tl e aid m this latte respect m t be l ght f th h re w th hardl a y t t l l l t ll more qu ckly

look the ffects f tl ed fi it cti n f en gen co d t ns of l fe —of so-c lled spo taneou ariat ns, which seem to d pen l m a qu te bord ate degree tl e n ture f the co d t ns,— f tl t d cy to re rs t l g lo t charact rs,— f tl complex l ws f gro tl ch f correl t n, compensatio of tl e pressure f n part tl &c. —and fi n lly f se ual selecti n by wh cl charact rs f use t se are ft g ined and tl en trai smitted m re less perfectl to the othe se th gh of no use t tl sex. ll l struct re thus i d ectly gained altl o gh t fir t of n d antage t a pec e, ma bseq entl h been taken ad ar t g of by ts mod f ed desce da ts, d conditions f life and n ly cq red l al ts

ad pt ti n to co ce f thus t ee-freq nti bird from ts n m and co sequentl that t was charact f mpo t ce and had been acq red thro gl n ral select n as t is tl e col ur is j obably m l f part d e to sex al select A trailing palm u tl e Malay Archi pel g limbs th l ft t tree by tl aid f quisit ly co tru ted l ook cl t ed around ll nd f the b ancl and tl is contri ance no d bt, is of th h gl est serv ce t tl plant but as w see l mila l ook n many tree wh h are n t limbers, and which, as ll re reaso t b l from the dist but n f th th m be ing pec es n Af ca and So th Am ri a, ser e as a d f ce agai t browsin j adrupeds, so the pik n tl palm m y t first h been d v l ped f r this object, and subseq tly l bee mpro d and tak ad ta f b th plant, as t

be, t may possibl be d t the direct ac ll f p trid m tt but w sh ld be very cautious m drawi g any ch inf ren wh n w see th t th skin on the h ad f the cl an

But Dr Crüger saw crowds of large humble bees visiting the gigantic flowers of this orchid *not in order to suck nectar* but to gnaw off the ridges within the chamber above the bucket in doing this they frequently pushed each other *into the bucket* and their wings being thus wetted they could not fly away but were compelled to crawl out through the passage formed *by the spout or overflow* Dr Crüger saw a continual procession of bees thus crawling out of their involuntary bath The passage is narrow and is roofed over by the column so that a bee in forcing its way out first rubs its back against the viscid stigma and then against the viscid glands of the pollen masses The pollen masses are thus glued to the back of the bee which first happens to crawl out through the passage of a lately expanded flower and are thus carried away Dr Crüger sent me a flower in spirits of wine with a bee which he had killed before it had quite crawled out with a pollen mass still fastened to its back When the bee thus provided flies to another flower or to the same flower a second time and is pushed by its com

to it and the flower is fertilised Now at last we see the full use of every part of the flower of the water secreting horns of the bucket half full of water which prevents the bees from flying away and forces them to crawl out through the spout and rub against the properly placed viscid pollen masses and the viscid stigma

The construction of the flower in another closely allied orchid namely the *Catasetum* is widely different though serving the same end and is equally curious Bees visit these flowers like those of the *Coryanthes* in order to gnaw the labellum in doing this they inevitably

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tion to a certain membrane which is instantly ruptured this sets free a spring by which the pollen mass is shot forth like an arrow in the right direction and adheres by its viscid extremity to the back of the bee The pollen mass of the male plant (for the sexes are separate in this orchid) is thus carried to the flower of the female plant where it is brought into contact with the stigma which is viscid enough to break certain elastic threads and retaining the pollen fertilisation is effected

How it may be asked in the foregoing and in innumerable other instances can we understand the graduated scale of complexity and the multifarious means for gaining the same end The answer no doubt is as already remarked that when two forms vary which already differ from each other in some slight degree the variability will not be of the same exact nature and consequently the results obtained through natural selection for the same general purpose will not be the same We should also bear in mind that every highly developed organism has passed through many changes and that each modified structure tends to be inherited so that each modification will not readily be quite lost but may be again and again further altered Hence the structure of each part of each species for whatever purpose it may serve is the sum of many inherited

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Finally then although in many cases it is most difficult even to conjecture by what transitions organs have arrived at their present state yet considering how small the proportion of living and known forms is to the extinct and unknown I have been astonished *how rarely an organ can be named towards* which no transitional grade is known to lead It certainly is true that new organs appearing *as if created for some special purpose rarely*

saltum We meet with this admission in the writings of almost every experienced naturalist or as Milne Edwards has well expressed it Nature is prodigal in variety but niggard in innovation Why on the theory of Creation should there be so much variety and so little real novelty Why should all the parts and organs of many independent beings each sup

Nature take a sudden leap from structure to structure? On the theory of natural selection we can clearly understand why she should not for natural selection acts only by taking advantage of slight successive variations she can never take a great and sudden leap but must advance by short and sure though slow steps.

Organs of little apparent Importance as affected by Natural Selection

As natural selection acts by life and death — by the survival of the fittest and by the des-

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feeding male turkey is likewise naked The sutures in the skulls of young mammals have been advanced as a beautiful adaptation for aiding parturition and no doubt they facilitate or may be indispensable for this act but as sutures occur in the skulls of young birds and reptiles which have only to escape from a broken egg we may infer that this structure has arisen from the laws of growth and has been taken advantage of in the parturition of the higher animals

by reflecting on the differences between the breeds of our domesticated animals in different countries —more especially in the less civilised countries where there has been but little methodical selection Animals kept by savages in different countries often have to struggle for their own subsistence and are exposed to a certain extent to natural selection and individuals with slightly different constitutions would succeed best under different climates. With cattle susceptibility to the attacks of flies is correlated with colour as is the liability to be poisoned by certain plants so that even colour would be thus subjected to the action of natural selection Some observers are convinced that a damp climate affects the growth of the hair and that with the hair the horns are correlated Mountain breeds always differ from lowland breeds and a mountainous country would probably affect the hind limbs from exercising them more and possibly even the form of the pelvis and then by the law of homologous variation the front limbs and the head would probably be affected The shape also of the pelvis might affect by pressure the shape of certain parts of the young in the womb The laborious breathing necessary in high regions tends as we have good reason to believe to increase the size of the chest and again correlation would come into play The effects of lessened exercise together with abundant food on the whole organisation is probably still more important and this as H von Nathusius has lately shown in his excellent treatise is apparently one chief cause of the great modification which the breeds of swine have undergone But we are far too ignorant to speculate on the relative importance of the several known and unknown causes of variation and I have made these remarks only to show that, if we are unable to account for the characteristic differences of our several domestic breeds which nevertheless are generally admitted to have arisen through ordinary generation from one or a few parent stocks we ought not to lay too much stress on our ignorance of the precise cause of the slight analogous differences between true species

Utilitarian Doctrine how far true Beauty how acquired

The foregoing remarks lead me to say a few words on the protest lately made by some naturalists against the utilitarian doctrine that every detail of structure has been produced for the good of its possessor They believe that many structures have been created for the sake of beauty to delight man or the Creator (but this latter point is beyond the scope of scientific discussion) or for the sake of mere variety a view already discussed Such doctrines if true would be absolutely fatal to my theory I fully admit that many structures are now of no direct use to their possessors and may never have been of any use to their progenitors but this does not prove that they were formed solely for beauty or variety No doubt the definite action of changed conditions and the various causes of modifications lately specified have all produced an effect probably a great effect independently of any advantage thus gained But a still more important consideration is that the chief part of the organisation of every living creature is due to inheritance and consequently though each being assuredly is well fitted for its place in nature many structures have no no very close and direct relation to present habits of life Thus we can hardly believe that the webbed feet of the upland goose or of the frigate bird are of special use to these birds we cannot believe that the similar bones in the arm of the monkey in the fore leg of the horse in the wing of the bat and in the flipper of the seal are of special use to these animals We may safely attribute these structures to inheritance But webbed feet no doubt were as useful to the progenitor of the upland goose and of the frigate bird as they now are to the most aquatic of living birds So we may believe that the progenitor of the seal did not possess a flipper but a foot with five toes fitted for walking or grasping but we may further venture to believe that the several bones in the limbs of the monkey horse and bat were originally developed on the principle of utility probably through the reduction of more numerous bones in the fin of some ancient fish like progenitor

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all th same to th m xo able princ ple f t ral selecti n. If we adm re the se e al in ious co tri ances, by which rch ds and many ther plants are fert li ed through insect agen y can w consid r as eq ally perfect the labor tio f d nse l d f poll n by r fir trees, so that f w gran le m y be wafted by chance o to the ovules

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understand be r ng in mind th t each organ c ng is trying to h e wh re er it can li how t has risen that there are upland geese w th w bb d feet, ground woodpeck di ing thru hes, and petr ls w th th h l ts f auks.

Althougl the b l ef tl at a org n so perfect as tl y co ld ha e been f ned by natu al select n, s n gh to stagg r any on t in th cas of any gan f w kno f a l i g series f grad f m comple ty eacl good fo its possesso the und r cl a gin co d t ns f l f th e is n l g c l mposs b l tv in th acq rement f any co cei able d gree f perfection thro l n tu al select In th case in wh ch we know f o inte med ate o tran t o al stat we c l o ld be e tren ly concl d g tl at n e can l

same fu t th h s g l een perfect h l t ded by tl e th r m st ften ha e l g ly fac l tated t ai t n

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In many cas w ar fa too ant t be abled to assert tl t p t or an so un

select I man tl as mod fi at are prob bly tl l ect re lt f th l w f n t f growth, d p nd tly of v good h g b tl s g ed B t e n cl tru t re h ft n, as we m y feel as ured bee b q ntly tak ad antage f d t ll f rther modified f th good f pec d n w cond t f l fe We m lso b h that part f m ly f h gh import n

which its eggs are deposited in the living bodies of other insects If it could be proved that any part of the structure of any one species had been formed for the exclusive good of another species it would annihilate my theory for such could not have been produced through natural selection Although many statements may be found in works on natural history to this effect I cannot find even one which seems to me of any weight It is admitted that the rattlesnake has a poison fang for its own defence and for the destruction of its prey but some authors suppose that at the same time it is furnished with a rattle for its own injury namely to warn its prey I would almost as soon believe that the cat curls the end of its tail when preparing to spring in order to warn the doomed mouse It is a much more probable view that the rattlesnake uses its rattle the cobra expands its frill and the puff adder swells whilst hissing so loudly and harshly in order to alarm the many birds and beasts which are known to attack even the most venomous species Snakes act on the same principle which makes the hen ruffle her feathers and expand her wings when a dog approaches her chickens but I have not space here to enlarge on the many ways by which animals endeavour to frighten away their enemies

Natural selection will never produce in a

purpose of causing pain or for doing an injury to its possessor If a fair balance be struck be

tions of life if any part comes to be injurious it will be modified or if it be not so the being will become extinct as myriads have become extinct

Natural selection tends only to make each organic being as perfect as or slightly more perfect than the other inhabitants of the same country with which it comes into competition. And we see that this is the standard of perfection attained under nature The endemic productions of New Zealand for instance are perfect one compared with another but they are now rapidly yielding before the advancing legions of plants and animals introduced from Europe Natural selection will not produce absolute perfection nor do we always meet as far as we can judge with this high standard under nature The correction for the aberration of light is said by Müller not to be perfect even in that most perfect organ the human eye Helmholtz whose judgment no one will dispute after describing in the strongest terms the wonderful powers of the human eye adds these remarkable words That which we have discovered in the way of inexactness and imperfection in the optical machine and in the image on the retina is as nothing in comparison with the incongruities which we have just come across in the domain of the sensations. One might say that nature has taken delight in accumulating contradictions in order to remove all foundation from the theory of a pre-existing harmony between the external and internal worlds If our reason leads us to admire with enthusiasm a multitude of inimitable contrivances in nature this same reason tells us though we may easily err on both sides, that some other contrivances are less perfect. Can we consider the sting of the bee as perfect, which when used against many kinds of enemies cannot be withdrawn owing to the backward serratures and thus inevitably causes the death of the insect by tearing out its viscera?

If we look at the sting of the bee as having existed in a remote progenitor as a boring and serrated instrument like that in so many members of the same great order and which has since been modified but not perfected for its present purpose with the poison originally adapted for some other object such as to produce

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for if on the whole the power of stinging be useful to the social community it will fulfil all the requirements of natural selection though it may cause the death of some few members. If we admire the truly wonderful power of scent by which the males of many insects find their females can we admire the production for this single purpose of thousands of drones which are utterly useless to the community for any other purpose and which are ultimately slaughtered by their industrious and sterile sisters It may be difficult, but we ought to admire the savage instinctive hatred of the queen bee which urges her to destroy the young queens her daughters as soon as they are born or to perish herself in the combat for undoubtedly this is for the good of the community and maternal love or maternal hatred though the latter fortunately is most rare is

all the same to the inexorable principle of natural selection. If we admire the several ingenious contrivances, by which orchids and many other plants are fertilised through insect agency, how can we consider as equally perfect the elaboration of dense clouds of pollen by our fir-trees, so that a few granules may be wafted by chance on to the ovules.

Summary: the Law of Unity of Type and of the Conditions of Existence embraced by the Theory of Natural Selection

We have in this chapter discussed some of the difficulties and objections which may be urged against the theory. Many of them are serious; but I think that in the discussion light has been thrown on several facts, which on the belief of independent acts of creation are utterly obscure. We have seen that species at any one period are not indefinitely variable, and are not linked together by a multitude of intermediate gradations, partly because the process of natural selection is always very slow, and at any one time acts only on a few forms; and partly because the very process of natural selection implies the continual supplanting and extinction of preceding and intermediate gradations. Closely allied species, now living on a continuous area, must often have been formed when the area was not continuous, and when the conditions of life did not insensibly graduate away from one part to another. When two varieties are formed in two districts of a continuous area, an intermediate variety will often be formed, fitted for an intermediate zone; but from reasons assigned, the intermediate variety will usually exist in lesser numbers than the two forms which it connects; consequently the two latter, during the course of further modification, from existing in greater numbers, will have a great advantage over the less numerous intermediate variety, and will thus generally succeed in supplanting and exterminating it.

We have seen in this chapter how cautious we should be in concluding that the most different habits of life could not graduate into each other; that a bat, for instance, could not have been formed by natural selection from an animal which at first only glided through the air.

We have seen that a species under new conditions of life may change its habits; or it may have diversified habits, with some very unlike those of its nearest congeners. Hence we can understand, bearing in mind that each organic being is trying to live wherever it can live, how it has arisen that there are upland geese with webbed feet, ground woodpeckers, diving thrushes, and petrels with the habits of auks.

Although the belief that an organ so perfect as the eye could have been formed by natural selection, is enough to stagger any one; yet in the case of any organ, if we know of a long series of gradations in complexity, each good for its possessor, then, under changing conditions of life, there is no logical impossibility in the acquirement of any conceivable degree of perfection through natural selection. In the cases in which we know of no intermediate or transitional states, we should be extremely cautious in concluding that none can have existed, for the metamorphoses of many organs show what wonderful changes in function are at least possible. For instance, a swimbladder has apparently been converted into an air-breathing lung. The same organ having performed simultaneously very different functions, and then having been in part or in whole specialised for one function; and two distinct organs having performed at the same time the same function, the one having been perfected whilst aided by the other, must often have largely facilitated transitions.

We have seen that in two beings widely remote from each other in the natural scale, organs serving for the same purpose and in external appearance closely similar may have been separately and independently formed; but when such organs are closely examined, essential differences in their structure can almost always be detected; and this naturally follows from the principle of natural selection. On the other hand, the common rule throughout nature is infinite diversity of structure for gaining the same end; and this again naturally follows from the same great principle.

In many cases we are far too ignorant to be enabled to assert that a part or organ is so unimportant for the welfare of a species, that modifications in its structure could not have been slowly accumulated by means of natural selection. In many other cases, modifications are probably the direct result of the laws of variation or of growth, independently of any good having been thus gained. But even such structures have often, as we may feel assured, been subsequently taken advantage of, and still further modified, for the good of species under new conditions of life. We may, also, believe that a part formerly of high importance

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as become of such small importance that it could not in its present state have been acquired by means of natural selection

Natural selection can produce nothing in one species for the exclusive good or injury of another though it may well produce parts or gans and excretions highly useful or even in di pensable or again highly injurious to another species but in all cases at the same time useful to the possessor In each well stocked country natural selection acts through the competition of the inhabitants and consequently leads to success in the battle for life only in accordance with the standard of that particular country Hence the inhabitants of one country generally the smaller one often yield to the inhabitants of another and generally the larger country For in the larger country there will have existed more individuals and more diversified form

selection will not necessarily lead to absolute perfection nor as far as we can judge by our limited faculties can absolute perfection be everywhere predicated

On the theory of natural selection we can clearly understand the full meaning of that old canon in natural history *Natura non facit saltum* This canon if we look to the present inhabitants alone of the world is not strictly correct but if we include all those of past times, whether known or

been formed on two great laws—Unity of Type and the Conditions of Existence By unity of type

of type is explained by unity of descent The expression of conditions of existence so often insisted on by the illustrious Cuvier is fully embraced by the principle of natural selection For natural selection acts by either now adapting the varying parts of each

parts being affected by the direct action of the external conditions of life and subjected in all cases to the several laws of growth and variation Hence in fact the law of the Conditions of Existence is the higher law as it includes through the inheritance of former variations and adaptations that of Unity of Type

CHAPTER VII

MISCELLANEOUS OBJECTIONS TO THE THEORY OF NATURAL SELECTION

I WILL devote this chapter to the consideration of various miscellaneous objections which have been advanced against my views, as some of the previous discussions may thus be made clearer; but it would be useless to discuss all of them, as many have been made by writers who have not taken the trouble to understand the subject. Thus a distinguished German naturalist has asserted that the weakest part of my theory is, that I consider all organic beings as imperfect: what I have really said is, that all are not as perfect as they might have been in relation to their conditions; and this is shown to be the case by so many native forms in many quarters of the world having yielded their places to intruding foreigners. Nor can organic beings, even if they were at any one time perfectly adapted to their conditions of life, have remained so, when their conditions changed, unless they themselves likewise changed; and no one will dispute that the physical conditions of each country, as well as the numbers and kinds of its inhabitants, have undergone many mutations.

A critic has lately insisted, with some parade of mathematical accuracy, that longevity is a great advantage to all species, so that he who believes in natural selection "must arrange his genealogical tree" in such a manner that all the descendants have longer lives than their progenitors! Cannot our critic conceive that a biennial plant or one of the lower animals might range into a cold climate and perish there every winter; and yet, owing to advantages gained through natural selection, survive from year to year by means of its seeds or ova. Mr. E. Ray Lankester has recently discussed this subject, and he concludes, as far as its extreme complexity allows him to form a judgment, that longevity is generally related to the standard of each species in the scale of organisation, as well as to the amount of expenditure in reproduction and in general activity. And these conditions have, it is probable, been largely determined through natural selection.

It has been argued that, as none of the animals and plants of Egypt, of which we know anything, have changed during the last three or four thousand years, so probably have none in any part of the world. But, as Mr. G. H. Lewes has remarked, this line of argument proves too much, for the ancient domestic races figured on the Egyptian monuments, or embalmed, are closely similar or even identical with those now living; yet all naturalists admit that such races have been produced through the modification of their original types. The many animals which have remained unchanged since the commencement of the glacial period, would have been an incomparably stronger case, for these have been exposed to great changes of climate and have migrated over great distances; whereas, in Egypt, during the last several thousand years, the conditions of life, ...

... period would have been of some avail against those who believe in an innate and necessary law of development, but is powerless against the doctrine of natural selection or the survival of the fittest, which implies that when variations or individual differences of a beneficial nature happen to arise, these will be preserved; but this will be effected only under certain favourable circumstances.

The celebrated palæontologist, Bronn, at the close of his German translation of this work, asks, how, on the principle of natural selection, can a variety live side by side with the parent species? If both have become fitted for slightly different habits of life or conditions, they might live together; and if we lay on one side polymorphic species, in which the variability seems to be of a peculiar nature, and all mere temporary variations, such as size, albinism, &c., the more permanent varieties are generally found, as far as I can discover, inhabiting distinct stations,—such as high land or low land, dry or moist districts. Moreover, in the case of animals which wander much about and cross freely, their varieties seem to be generally confined to distinct regions.

Bronn also insists that distinct species never differ from each other in single characters, but in many parts; and he asks, how it always comes that many parts of the organisation should have been modified at the same time through variation and natural selection? But there is no necessity for supposing that all the

parts of any being have been simultaneously modified The most striking modifications, excellently adapted for some purpose might as was formerly remarked be acquired by successive variations if slight first in one part and then in another and as they would be transmitted all together they would appear to us as if they had been simultaneously developed The best answer however to the above objection is afforded by those domestic races which have been modified chiefly through man s power of selection for some special purpose Look at the race and dray horse or at *the greyhound and mastiff Their whole frames* and even their mental characters have been modified but if we could trace each step in the history of their transformation —and the latter steps can be traced —we should not see great and simultaneous change but first one part and then another slightly modified and improved Even when selection has been applied by man to some one character alone —of which our cultivated plants offer the best instances —it will invariably be found that although this one part whether it be the flower fruit or leaves has been greatly changed almost all the other parts have been slightly modified This may be attributed partly to the principle of correlated growth and partly to so-called spontaneous variation

A much more serious objection has been urged by Bronn and recently by Broca namely that many characters appear to be of no service whatever to their possessors and therefore cannot have been influenced through natural selection Bronn adduces the length of the ears and tails in the different species of hares and mice —the complex folds of enamel in the teeth of many animals and a multitude of analogous cases With respect to plants this subject has been discussed by Nageli in an admirable essay He admits that natural selection has effected much but he insists that the families of plants differ chiefly from each other

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tendency towards progressive and more perfect development. He specifies the arrangement of the cells in the tissues and of the leaves on the axis as cases in which natural selection could not have acted To these may be added the numerical divisions in the parts of the flower the position of the ovule the *shape* of the seed when not of any use for dissemination &c.

There is much force in the above objection. Nevertheless we ought in the first place to be extremely cautious in pretending to decide what structures now are or have formerl been of use to each specie In the second place it should alway be borne in mind that *when one part is modified so will be other* parts through certain dimly seen causes, such as an increased or diminished flow of nutriment to a part mutual pressure an early developed part affecting one subsequently developed and so forth —as well as through other cause which lead to the many mysterious cases of correlation which we do not in the least understand These agencies may be all grouped together for the sake of brevity under the expression of the laws of growth In the third place we have to allow for the direct and definite action of changed conditions of life and for so-called spontaneous variations, in which the nature of the conditions apparently plays a quite subordinate part Bud variation such as the appearance of a moss rose on a common rose or of a nectarine on a peach tree offer good instances of spontaneous variations but even in these cases if we bear in mind the power of a minute drop of poison in producing complex galls we ought not to feel too sure that the above variations are not the effect of some local change in the nature of the sap due to some change in the conditions There must be some efficient cause for each slight individual difference as well as for more strongly marked variations which occasionally arise and if the unknown cause were to act persistently it is almost certain that all the individuals of the species would be similarly modified

In the earlier editions of this work I underrated as it now seems probable the frequency and importance of modifications due to spontaneous variability But it is impossible to attribute to this cause the innumerable structures which are so well adapted to the habits of life of each species I can no more believe in this than that the well adapted form of a race horse or greyhound which before the principle of selection by man was well understood excited so much surprise in the minds of the older naturalists can thus be explained

It may be worth while to illustrate some of

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organ t som of th pecies ... be much infl ced by ts l ngth.

W th respect to plants, t which on account of N h s essay I shall confin m self in th following remarks, t w ll be admitted th t th fl ers of rchids prese t a m lt t d of curi ous tructures, which f w ears ago w uld ha been considered mere m rph logical diff rences w tho t an pecial functi b t th y re now kno n t be of th l ghest im

morphic and trim rphi plants th diff re t l gths of the stamens and pistils, and th ir ar rang ment, could h been of an service b t now w know thus t be the case

In certain whole gro ps f plants th ules stand rect, and in thers th y are suspended and within the sam arium of som f w plants, one ule h ld th f rm and sec nd ule th latter positio These posit ns seem at first purely morphol gical, o of no ph siological significatio b t D Hook form m th t within th sam arium, th ppe ules alo in som cases, and in th r cases the lo er nes alon are fertilised and h suggests that this probabl depends n th di rection in which th poll n-tubes ent r th arium. If so, th position of th ules, n hen on is rect and the ther uspended with in th same arium, w uld follow from th selection of any l ght d iations in position hich f ured their f rtilisation, and the pro duction of seed.

Se eral plants belo ging to distinct rd rs hal tually produce fl w rs f tw kinds,—the one pe of th rdinary tructure, th ther closed and imperfect. These tw kinds of fl w ers som times diff wond rfully tructure, y t may be see t graduat int ach th on the sam plant. Th ordinary and pen fl rs can be tercrossed and the benefits which cer tainly are d rived from this process are thus secured. The closed and imperfect flowers are howev r manifestly f h gh mportance as th y y ld with th utmo t saf ty a large tock of seed with the expe diture of w nd rfully little pollen. The two k ds f fl wers often dif fer m ch, as y t tated, in truct re. The pet als in th imperfect flowers almost alw con sist f mere rudiments, and the pollen grains are red ced in diam te In *Ono* *col m a* fi of the alt rnate stamens are rud m t ary and in som species of *V ola* three tam ns are in this tate, two retainin th proper func tion, but being of ry small size. I six ut f thirt of th cl sed fl wers in an Indian olet (nam unkn wn f r th plants hav ne r pro duced with m perfect fl wers) the sepals are red ced from th rmal numb of fi e to three In e secti n of the *Malp ghiaceæ* the closed fl w rs, according to A. de J ss are till furth r modified f r the fi tamen

n t present in th ordinary fl wers f th s pecies th tyl is aborted and the ari are red ced from three to two N w lth gh n t ural selecti n may well ha had th powe to pre nt som of th flow rs f m xpand and to red ce the amount f poll n, wh n ren d red b th cl re of the fl w rs sup flu yet hardly any of th abo special modifica tions can ha been thus d termined b t must ha f llowed from the law of growth lud ing the funct nal inacti ity f parts, during th progress f th red ti n of th poll n and th clo ure of the fl w rs.

It is so necessary to pprec t the impo tant ffects f th l w of growth, th t I will gi som add ti nal cases of an th er ki d n m l of diff re ces in th sam part gan d t d ff rences in relati e position on th sam plant. In th Spanish chestn t, d in certain fi trees, th angles f di rg ce of th l es diff according t Sch cht t the nearly h rizo tal a d in th upright bran h s. In the comm ru and som ther plants, o fl w us ally th central t min l n opens first, and has fi sepal and petals, and fi d si ns to th ari m whil t ll the th r fl w rs th plant are t tram rous. In th British *Ad* the uppermost fl wer g n rally has tw calyx lobes w th th otl gans t tramerous, whilst the urround ng fl w rs generally h e three calyx lobe w th th oth organs pentam rous. In ma y Composi

tæ and Umbelliferæ (and in some other plants) the circumferential flowers have their corollas much more developed than those of the centre and this seems often connected with the abortion of the reproductive organs It is a more curious fact previously referred to that the achenes or seeds of the circumference and centre sometimes differ greatly in form colour and other characters In *Carthamus* and some other Compositæ the central achenes alone are furnished with a pappus and in *Hyoseris* the same head yields achenes of three different forms In certain Umbelliferæ the exterior seeds according to Tausch are orthospermous and the central one cœlospermous and this is a character which was considered by De Candolle to be in other species of the highest systematic importance Prof Braun mentions a Fumariaceous genus in which the flowers in the lower part of the spike bear oval ribbed one seeded nutlets and in the upper part of the spike lanceolate two valved and two-seeded siliques In these several cases with the exception of that of the well developed ray florets which are of service in making the flowers conspicuous to insects natural selection cannot as far as we can judge have come into play or only in a quite subordinate manner All these modifications follow from the relative position and inter action of the parts and it can hardly be doubted that if all the flowers and leaves on the same plant had been subjected to the same external and internal condition as are the flowers and leaves in certain positions all would have been modified in the same manner

In numerous other cases we find modifications of structure which are considered by botanists to be generally of a highly important nature affecting only some of the flowers on the same plant or occurring on distinct plants which grow close together under the same conditions As these variations seem of no special use to the plants they cannot have been influenced by natural selection Of their cause we are quite ignorant we cannot even attribute them as in the last class of cases to any proximate agency such as relative position I will give only a few instances It is so common to observe on the same plant flowers indifferently tetramerous pentamerous &c that I need not give examples but as numerical variations are comparatively rare when the parts are few I may mention that according to De Candolle the flowers of *Papaver bracteatum* offer either two sepals with four petals (which is the common type with poppies) or three sepals with six petals The manner in which the petals are folded in the bud is in most groups a very constant morphological character but Professor Asa Gray states that with some species of *Mimulus* the æstivation is almost as frequently that of the Rhinanthideæ as of the Antirrhinideæ to which latter tribe the genus belongs Auguste de Saint Hilaire gives the following cases the genus *Zanthoxylon* belongs to a division of the Rutaceæ with a single ovary

the capsule has been described as unilocular or trilocular and in *H mutabile* *Une lame plus ou moins large s'étend entre le péricarpe et le placenta* In the flowers of *Saponaria officinalis* Dr Masters has observed instances of both marginal and free central placentation Lastly Saint Hilaire found towards the southern extreme of the range of *Gomphia oleæformis* two forms which he did not at first doubt were distinct species but he subsequently saw them growing on the same bush and he then adds *Voilà donc dans un même individu des loges et un style qui se rattachent tantôt à un axe verticale et tantôt à un gynobase*

We thus see that with plants many morphological changes may be attributed to the laws of growth and the inter action of parts independently of natural selection But with respect to Nägeli's doctrine of an innate tendency towards perfection or progressive development can it be said in the case of these strongly pronounced variations, that the plants have been caught in the act of progressing towards a higher state of development? On the contrary I should infer from the mere fact of the parts in question differing or varying greatly on the same plant that such modifications

said to raise an organism in the natural scale and in the case of the imperfect, closed flowers above described if any new principle has to be invoked it must be one of retrogression rather than of progression and so it must be with many parasitic and degraded animals We are ignorant of the exciting cause of the above specified modifications but if the unknown cause were to act almost uniformly for a length of time we may infer that the result would be almost uniform and in this case all the indi

viduals f th species w ld be modified in the sam mann

From th fact f th abo e characters being important f th welfare of th spec s, any l l t n ti ns which occ rred in th m wo ld

B t h n, from th nat re f the rganism and f th condit ns, modificat ns ha bee ind ced wh ch are un mpo tant f the w lf re f th spec s, th may be and ppare tly ofte h bee t ansm tted in n ly the sam tate t n m rous, therwise modified, desce dants. It cann t h been of m ch im portance t th gre t numb of mammals, birds, reptil wh th they were l thed w th hai f th s, cal t hair has been

is ft ass med to be f h gh tal mportance t th pec es. Thus, as I am in lined t be- li e, m rph l cal diff re ce wh ch w co sid as important— ch as th rrang m t of th l s, th d isi ns f th fl w f th ari m th po t f th ules, &c.— first ppeared in many case as t ting ariat ns, which soo lat becam co ta t thr gh th nat re f th rganism and f th rroundin co d t ons, as w ll as thro h tl int rcrossing f dist ct indi d als, b t t thro gh nat ral selecti f as these m rph l g al charact rs d t affect th lfar f tl pec s, y sl ght d ti ns tl m could t ha bee g rned o ac cum l ted thro l th latt gen y It is a trang result which w th arri t, am ly that haract rs f light tal mportance ll spec es, are th m t impo tant t th ys- temat t b t, as shall l reafte see wh n treat f th g t prin pl f lass fica t n, this is by m ans so parad xical as t ma t first ppear

Alth gl w h good d nce of th ist ce gani be f an innat tend enc t ward progress d l pment, y l th cessarily f ll s, as I h tt mpted t h in tl f urth hapt thro gh th co tin ed actio of nat ral selecti n. k th best

defin stan th tiat e d asm ch as th parts to perfo m the functions more effic ntly

pa fa and cons d at ns oppo ed t his on clus ns, n slight ff f reason and mem ry is l ft to th read who m y w h to we h th dence n both des. Wh n d sc ssing

der D m t t t gre t l gth than as I b h any th rit r H liken se ft n assumes th t I ttr b t n thing t ar ti n independ tly f tural selecti whereas in th w k y t ref rred to I h collected a gre t numb f w ll-e tabl hed case than can b f und in an th wo k kn wn to me. My j dgm nt may n t be tru tw rthy but aft read n w th care Mr M art book, and compa ach secti n w th wh t I h e said th sam head I n bef re f lt so tro g ly co ced f th g ral truth f the con cl ns h ar ed t, bject, of co rse, in so int cat bject t m ch p rt al ro

All Mr M art objecti ns will b h been, consid ed in th prese t lum The ne n w po t wh ch ppe rs to h truck many read rs s, th t t al select n incompe t t t account f th p ent stag f use- ful tru t res. This bject intim t ly con nected w th th t f th grad ti n f ch t rs, ft n accompan ed by a chang f f

art select th se wh ch are th m t illus- trat as w t f pac pre nts me from co d g ll.

Th g raff by t l fty stat re m l I n g t d eck, f re-l gs, h ad and to gu has ts

whole frame beautifully adapted for browsing on the higher branches of trees. It can thus obtain food beyond the reach of the other Ungulata or hoofed animals inhabiting the same country; and this must be a great advantage to it during dearths. The Niata cattle in S. America show us how small a difference in

grass, but from the projection of the lower jaw they cannot, during the often recurrent droughts, browse on the twigs of trees, reeds, &c., to which food the common cattle and horses are then driven; so that at these times the Niatas perish, if not fed by their owners. Before coming to Mr. Mivart's objections, it may be well to explain once again how natural selection will act in all ordinary cases. Man has modified some of his animals, without necessarily having attended to special points of structure, by simply preserving and breeding from the fleetest individuals, as with the race-horse and greyhound, or as with the game-cock, by breeding from the victorious birds. So under nature with the nascent giraffe, the individuals which were the highest browsers and were able during dearths to reach even an inch or two above the others, will often have been preserved; for they will have roamed over the whole country in search of food. That the individuals of the same species often differ slightly in the relative lengths of all their parts may be seen in many works of natural history, in which careful measurements are given. These slight proportional differences, due to the laws of growth and variation, are not of the slightest use or importance to most species. But it will have been otherwise with the nascent giraffe, considering its probable habits of life; for those individuals which had some one part or several parts of their bodies rather more elongated than usual, would generally have survived. These will have intercrossed and left offspring, either inheriting the same bodily peculiarities, or with a tendency to vary again in the same manner; whilst the individuals less favoured in the same respects will have been the most liable to perish.

We here see that there is no need to separate single pairs, as man does, when he methodically improves a breed: natural selection will preserve and thus separate all the superior individuals, allowing them freely to intercross, and will destroy all the inferior individuals. By this process long-continued, which exactly corresponds with what I have called unconscious selection by man, combined no doubt in a most important manner with the inherited effects of the increased use of parts, it seems to me almost certain that an ordinary hoofed quadruped might be converted into a giraffe.

To this conclusion Mr. Mivart brings forward two objections. One is that the increased size of the body would obviously require an increased supply of food, and he considers it as very problematical whether the disadvantages thence arising would not, in times of scarcity, more than counterbalance the advantages. But as the giraffe does actually exist in large numbers in S. Africa, and as some of the largest antelopes in the world, taller than an ox, abound there, why should we doubt that, as far as size is concerned, intermediate gradations could formerly have existed there, sub-

other hoofed quadrupeds of the country would have been of some advantage to the nascent giraffe. Nor must we overlook the fact, that increased bulk would act as a protection against almost all beasts of prey excepting the lion; and against this animal, its tall neck,—and the taller the better,—would, as Mr. Chauncey Wright has remarked, serve as a watch-tower.

determined by any one advantage, but by the union of all, great and small.

Mr. Mivart then asks (and this is his second objection), if natural selection be so potent, and if high browsing be so great an advantage, why has not any other hoofed quadruped acquired a long neck and lofty stature, besides the giraffe, and, in a lesser degree, the camel, guanaco, and macrauchenia? Or again, why has not any member of the group acquired a long proboscis? With respect to S. Africa, which was formerly inhabited by numerous herds of the giraffe, the answer is not difficult, and can best be given by an illustration. In every meadow in England in which trees grow, we see the lower branches trimmed or planed to an exact level by the browsing of the horses or cattle; and what advantage would it be, for instance, to sheep, if kept there, to acquire slightly longer necks? In every district some

on kind of animal will almo.t certainly be able t browse higher than th the and t is almost equally certain that this kind alo e co ld ha ts eck lo gated f th s p rpose thro gh nat ral select n and tl ffects of n creased use In S. Africa th compet t n f bro sing th hi h branches f the acacias and ther trees must be bet een giraffe and giraffe, and not w th the oth r ungulate an mals.

Why in tl r quarters f the w ld ar us animals belo gin to this sam rd ha n t acquired either an lo g ted eck probos cis, cannot be d tin tl ans red b t t is as unreasonable to xpect d t ct an we t s ch q estion, as why som t in th h tory f mankind d d n t occur in country whilst t did in anoth r We are gn rant w tl respect to th cond tions which d termin ll mbe and rang f ach spec es and w cann t e n co ject re what changes f tr t re w ld be f ral l t t ncrease some n w co try W can, l see in g al mann that arious causes m gl t h nt rf red w th th d lopm t f lo g eck probosc is. T reach th f lag t co d rabl l gl t (with out h b f wh ch hoofed animals re g larly l-co istru t d) mpl gre tly n sed b lk f bod and w kn w that som areas pport gula l f w larg q adrupeds, f instance S Am ri a, th gh t is so luxu ia t l ilst S Africa abo d w th th m t an parall led d gree Wh t h ld be so d t kno n l tl lat t tiary period ho ld ha bee so m cl m re f urabl f th ll nce than tl prese t tim Wl t th ca se ma ha been, we can see that certain d tricts and tim ld ha bee m cl m re f urabl than th rs f th d lopm t of so large quadruped as tl g raff

I ord that an nimal sh uld acq re som truct re specially and largely d loped t almost nd pensabl that ses ral tl p rts sl ld be mod fied and co-ad pted Altl gl every part f th bod aries sl ghtl t does not f llo that th ecessary parts sl ld al ary in th ght directio and to th ght d gree W th th d ff re t pec es f do estic ted ani nals w k w tl t the parts ary in d ff r t mann and d gree and that som speci are m h m re ariable than oth rs. E n if th fitt g ariatio d l arise, t does not f llow that natural selectio would be able to act th m, and prod ce truc ture hich pparently w ld be benefi ial t

ch nr t m t ces —

n e

retarded in mod f an part cular truc ture f r obtain g food Lastly nat al selec f low process, and th sam fa u ble

— —

w cann t xplain wh in many pa rt s of tl w ld, hoofed quadrupeds l e n t ac

g ing ha been ad anced by ma y w t rs. In each case ari s uses, bes d th ge ral es j t d cated l prob bly i t rf red w th th acq t thro h nat al sel ct n f tru t res, whi h f th ght wo ld be be f al t certain pec es. O e writer asks, wh has n t th o trich cquired th pow f fl ght B t a m in t reflection will h w what an rm pply f food w ld be ecessar t t this b rd f th desert f rce to m ts h g body through tl air Oceanic i land re inhab ted b b ts and seal b t by t rre trial mammal t as some of tl ese b ts are peculiar spec s, tl y mu t ha l g inhab ted th ir pre nt l mes. Th ref re S C Ly ll asks, and ass gns certain reasons i ans wh h e n t se ls and bats gi n birth d slands to f rms fitted to l n th land B t seals w uld necessaril be first co rted into terre trial carn ro anim ls f cons d rabl ar d b nt terrestri l insect ro animals f th f rm tl re w ld be prey f th b ts gro d nsects w l serv as food, but tl w ld already be larg ly pre d n l y th rept les b rds, wh ch fi t colo se and abo d most oce anic lands. G ad t f tr t re w th each tag ben f cial to changi g speci s, w ll be f red l u d certa n pec liar co di ti ns. A ctl t rre trial an mal, by occa si ll h ti g f food n shall w w te

—

fi d oceanic island th co d t fav able to th gradual recon rsion into a t re trial f rm. B ts, as f rm ly sh wn, prob ably acq red th ir wi gs by t first glidi g thro gh tl air from tree to tree, lik the so

called flying squirrels for the sake of escaping from their enemies or for avoiding falls but when the power of true flight had once been acquired it would never be reconverted back at least for the above purposes into the less efficient power of gliding through the air Bats might indeed like many birds have had their wings greatly reduced in size or completely lost through disuse but in this case it would be necessary that they should first have acquired the power of running quickly on the ground by the aid of their hind legs alone so as to compete with birds or other ground animals and for such a change a bat seems singularly ill fitted These conjectural remarks have been made merely to show that a transition of structure with each step beneficial is a highly complex affair and that there is nothing strange in a transition not having occurred in any particular case

Lastly more than one writer has asked why have some animals had their mental powers more highly developed than others as such development would be advantageous to all? Why have not apes acquired the intellectual powers of man? Various causes could be assigned but as they are conjectural and their relative probability cannot be weighed it would be useless to give them A definite answer to the latter question ought not to be expected seeing that no one can solve the simpler problem why of two races of savages one has risen higher in the scale of civilisation than the other and this apparently implies increased brain power

We will return to Mr Mivart's other objections Insects often resemble for the sake of protection various objects such as green or decayed leaves dead twigs bits of lichen flowers spines excrement of birds and living insects but to this latter point I shall hereafter recur The resemblance is often wonderfully close and is not confined to colour but extends to form and even to the manner in which the insects hold themselves The caterpillars which project motionless like dead twigs from the bushes on which they feed offer an excellent instance of a resemblance of this kind The cases of the imitation of such objects as the excrement of birds are rare and exceptional On this head Mr Mivart remarks As according to Mr Darwin's theory there is a constant tendency to indefinite variation and as the minute incipient variations will be *in all directions* they must tend to neutralise each other and at first to form such unstable modifica-

l ... can ever build up a sufficiently appreciable resemblance to a leaf bamboo or other object for Natural Selection to seize upon and perpetuate

But in all the foregoing cases the insects in their original state no doubt presented some rude and accidental resemblance to an object commonly found in the stations frequented by them Nor is this at all improbable considering the almost infinite number of surrounding objects and the diversity in form and colour of the hosts of insects which exist As some rude resemblance is necessary for the first start, we can understand how it is that the larger and higher animals do not (with the exception as far as I know of one fish) resemble for the sake of protection special objects but only the surface which commonly surrounds them and this chiefly in colour Assuming that an insect originally happened to resemble in some degree a dead twig or a decayed leaf and that it varied slightly in many ways then all the variations which rendered the insect at all more like any such object and thus favoured its escape would be preserved whilst other variations would be neglected and ultimately lost or if they rendered the insect at all less like the imitated object they would be eliminated There would indeed be force in Mr Mivart's objection if we were to attempt to account for the above resemblances independently of natural selection through mere fluctuating variability but as the case stands there is none

Nor can I see any force in Mr Mivart's difficulty with respect to the last touches of perfection in the mimicry as in the case given by Mr Wallace of a walking stick insect (*Ceroxylus laceratus*) which resembles a stick grown over by a creeping moss or jungermannia So close was this resemblance that a native Dyak maintained that the foliaceous excrescences were really moss Insects are preyed on by birds and other enemies whose sight is probably sharper than ours and every grade in resemblance which aided an insect to escape notice or detection would tend toward its preservation and the more perfect the resemblance so much the better for the insect Considering the nature of the differences between the species in the group which includes the above Ceroxylus there is nothing improbable in this insect having varied in the irregularities on its surface and in these having become more or less green-coloured for in every group the

characters wh ch d ff in the sev ral specie are th m t pt to ary whilst the gen ri charact rs, r those comm t all the peci s, are th most constant.

Tl Greenland whale is e of th most nderful animals in th w ld and th baleen, whal bo e, f ts gre test peculi rities. Th baleen consists f row ach d f th pper j w f abo t 300 pl tes laminæ, l h tand lose tog th tran rsel to th l g ax f th m th. W thin tl main row tl re are som b diary ro s. Th trem t es and inn margins of all th plates are f ed into tiff b istl s, which cl th th hol gigantic palat and serv t train ft th t and tl t sec re th min te pre h h these gre t animals b ist. Th middle and lo gest lamina th Greenland hal is ten, tw l fifteen feet in l gth b t in th d ff re t species f ceta ceans th re re grad t in l gth th mid dle lam na being species, according t Scoresb f fect, in an th three, an th ghtee in l es, and th Balæn pt rostrata ly bo t inches in l gth. The q lity of th whale-bo also diff rs in th d f re t peci s.

W th respect t th baleen, Mr Mi art remarks that if t had nce ttained uch a size and d lopm t as to be t all usef l, th n ts preserv t and gm tatio w thin se abl l mits w ld be prom ted b t ral sel t alo B t h t btai th begin nin of h sef l d lopm t In an l m be asked, wl y h ld n t th ly progs t rs of th lales th balee ha possessed mo th co tru ted som thi g lik the lam llated beak f d ck D ks, lik whales, l t b dts g th m d and w t and th fan l has som t m bee called Criblat res, ft rs. I h pe th t I ma n t be misco trued t sa ing th t th pro nit rs f hales did act ally possess m this lam llated l ke tl beak f d k. I wish nl t h w tl t tl not incred l l and that th m m se plat f balee th Gree land whal m ht l bee d loped from h lam llæ l f f grad ted t ps, ach f serv ce to ts pos sso

Tl beak f h ll d k (Spat l l) pe is m re be tif l and compl x truc ture than th mouth f l a. Th ppe mandible is furnished ach (in tl pe cime xamined b m) with row comb formed of 188 thin, last lam llæ obliq ely be lled so as to be pointed and placed t ans rsely t tl lo ge axis of the m th They

l g t, being about o e th rd of an inch in l gth, and th y project 14 f an inch ben th th edg At th ir bases there i sh rt ub diary row f obliq ly trans rse lam llæ. In these se ral re pects th y resemble the plates f baleen in th m th f a whale But towards the xtrem ty of tl beak th y d ff r much as tl y project inwards, t ad of straight d wnwards. The nt re h ad f the sh ll th gh incomparably l ss bulky is abo t o e-eighteenth of the l gth f th head of mod rat ly larg Balæn pt a ostrata, in whi h peci the baleen only nin inch l so that f we w re t make the h ad of th sl ll rasl g as that f the B læ ptera th lam llæ w uld be ix inch in l gth—

equal l gth w th those abo but fin and in bein th furnisl ed it diff rs con p sly from th l r j w f a whale, wh ch is d ti t t f baleen. O th the hand tl extrem ties f these low lam llæ re fra ed int fine b tl points, so that th y th curi ly re semble th plates f balee I th g l n n a m mbe of th dist t f mil f th petrels, th ppe mand bl al is f rnished w th lam llæ which are w ll d loped and project be e th th margin so that th beak of this b rd resembl in this respect th m th of a whale.

From th h hly d l ped tru ture f th h ll b ak w may proceed (as I ha e l arnt from inf rm tio and spec m ns sent to m b Mr Sal in) w th t any re t break as far as fitness f fting co cerned thro gh th beak f th M g etta rm t and in som respects thro gh th t f tl l r po t th beak f th comm d k. In this latt r pe cies th l m llæ re m ch coarse than in th l ll d are firml ttached t th d f th mandibl th are nly bo t 0 in mbe ach id and d ot project t all ben th tl m rgin Tl are sq re t pped, an l re ed ed w th tran l ce t hard h t ssu as f f rushin food. Th edg f th l w mand l l re ro sed b n m rous fin ridg s, wh ch project ry littl Altho h the b ak thus ry inf rio as ft to th t f th sho ll y t this bird, as ery o kn ws,

constantly uses it for this purpose There are other species as I hear from Mr Salvin in which the lamellæ are considerably less developed than in the common duck but I do not know whether they use their beaks for sifting the water

Turning to another group of the same family in the Egyptian goose (Chenalopex) the beak closely resembles that of the common ducks but the lamellæ are not so numerous nor so distinct from each other nor do they project so much inwards yet this goose as I am informed by Mr E Bartlett uses its bill like a duck by throwing the water out at the

[illegible]

are much coarser than in the common duck almost confluent about 27 in number on each side and terminating upwards in teeth like knobs The palate is also covered with hard rounded knobs The edges of the lower mandible are serrated with teeth much more prominent coarser and sharper than in the duck The common goose does not sift the water but uses its beak exclusively for tearing or cutting herbage for which purpose it is so well fitted that it can crop grass closer than almost any other animal There are other species of geese as I hear from Mr Bartlett in which the lamellæ are less developed than in the common goose

We thus see that a member of the duck family with a beak constructed like that of the common goose and adapted solely for grazing

[illegible]

goose —this into one like the common duck —and lastly into one like the shoveller provided with a beak almost exclusively adapted for sifting the water for this bird could hardly use any part of its beak except the hooked tip for seizing or tearing solid food The beak of a goose as I may add might also be converted by small changes into one provided with prominent recurved teeth like those of the merganser (a member of the same family) serving for the widely different purpose of securing live fish

Returning to the whales the *Hyperoodon bidens* is destitute of true teeth in an efficient condition but its palate is roughened according to Lacepede with small unequal hard points of horn There is, therefore nothing improbable in supposing that some early cetacean form was provided with similar points of horn on the palate but rather more regularly placed and which like the knobs on the beak of the goose aided it in seizing or tearing its food If so it will hardly be denied that the points might have been converted through variation and natural selection into lamellæ as well developed as those of the Egyptian goose in which case they would have been used both for seizing objects and for sifting the water then into lamellæ like those of the domestic duck and so onwards until they became as well constructed as those of the shoveller in which case they would have served exclusively as a sifting apparatus From this stage in which the lamellæ would be two-thirds of the length of the plates of baleen in the *Balænoptera rostrata* gradations which may be observed in still-existing cetaceans lead us onward to the enormous plates of baleen in the Greenland whale Nor is there the least reason to doubt that each step in this scale might have been as serviceable to certain ancient cetaceans with the functions of the parts slowly changing during the progress of development as are the gradations in the beaks of the different existing members of the duck family We should bear in mind that each species of duck is subjected to a severe struggle for existence and that the structure of every part of its frame must be well adapted to its conditions of life

The Pleuronectidæ or flat fish are remarkable for their asymmetrical bodies They rest on one side —in the greater number of species on the left but in some on the right side and occasionally reversed adult specimens occur The lower or resting surface resembles at first sight the ventral surface of an ordinary fish it is of a white colour less developed in many ways than the upper side with the lateral fins often of smaller size But the eyes offer the most remarkable peculiarity for they are both placed on the upper side of the head During early youth however they stand opposite to each other and the whole body is then symmetrical with both sides equally coloured Soon the eye proper to the lower side begins to glide slowly round the head to the upper side but does not pass right through the skull as was formerly thought to be the case It is obvious that unless the lower eye did thus travel round it could not be used by the fish whilst lying in its habitual position on one side The lower eye would also have been liable to be abraded by the sandy bottom That the

common... The ch f ad antages th s gained seem t be protect from th r m s, and facility f feedi g th ground Th diff re t m mbers, h f th f mil present, as Sch dt rema ks, lo seri f f rms x hib ting grad al t ans ti from *Hippoglossus p g u* whi h does t in any cons d rable d gree alt the shape in which t lea es th o um to tl soles, wl are t rely thrown to side.

M M art has tak p th ase and marks that sudd po taneous t ansf rm tio tl po ti f th yes hardly co

far from cl ar It seems, n, that ch an u p ent transf mat m st rall er h been

th h ad cann t l g retai rt cal po tion, g to th cessi depth f tl ir bod es, tl mall iz f th lat al fins, nd to tl b g dest t t f a imbladd H ce soo gro g t red, th y fall t th bott m id Whilst thus at est th y ft n tw t, as M lm observed th l i ards, t ser also th in and th y d th so g ro sly th t tl press l l and gainst th ppe part f tl rb t Tl f reh ad bet ee th es co seq tl becomes, as o ld be plain- ly seen, t mporaril co t acted breadth. O on occas Malm saw y g fi l ise and d p re tl lo thro gl an angula d s- tance of abo t se t l grees.

W h mi that th skull t tl is arly ag is rt la ar l flex ble, so that t readil ield to use la action. It also kno w tl tl h gl an mals, ft early y lh, that th k ll l l and altered in shape if tl sk m scles be pe man tly contracted th l d ease som accid t W th lo g-eared abl ts, if ar lops f l and d ards, ts w ght drag f ward all tl bo es f th k ll on tl same side, of hich I ha f gure Malm tates that th ewly l tched g f perch

es, s, o e si that they ften then train the l w r y so as to look upw rd and tl kulls re thus rend red rathe rooked Tl e fi l s l w re on l le to h ld th m l es in a

tl e l ad and n tl e posit f tl es. J dg from logy th t d cy t listort n

s d and th pecies n tl r gl t d Malm

l t th bott m and wims lug ally tl ro gh th w t d in tl fi h th two les f th l ad are said t l so l t d m la O great a th rity o fish s D G tl er o l d his ab tract f Malm s pape b re ark th t th a th g es a ery mpl planation f the bnormal co d t n f th pl ro ecto d

W thus ee th t the first tag f th tran t f th from e d f tl h ad t tl th which Mr M art consid rs w ld b inj s, m y be attrib ted to tl habt n d l t be fi ial to th ind vi l al d to th pec es, f d a rn to look up ards tl both yes, wh lst resting o d t th bot tom W may also attrib t t th inh ted ffects f use th fact f th m th in se l kinds f flat fish b ing be t towards tl l w urf ce, w th th j w bo tro g and m re ffect tl s, th y l s l f tl head, than tl tl f tl sak as Dr Traq poses, f feedin w th ase tl ground D suse tl th hand will acco t f th less d el ped ond t f th wh l infe half f tl body ncl d th lat ral fins tho gl Y rrel thinks that tl red ced iz f th se fins is ad ant geo t th fish as th is so m ch l ss oom f tl act n, tl w th th larger fins abo l hap the l sse n m be f teeth in the proportion f f ur to se n

in the upper halves of the two jaws of the plaice, to twenty-five to thirty in the lower halves, may likewise be accounted for by disuse. From the colourless state of the ventral surface of most fishes and of many other animals, we may reasonably suppose that the absence of colour in flat-fish on the side, whether it be the right or left, which is undermost, is due to the exclusion of light. But it cannot be supposed that the peculiar speckled appearance of the upper side of the sole, so like the sandy bed of the sea, or the power in some species, as recently shown by Pouchet, of changing their colour in accordance with the surrounding surface, or the presence of bony tubercles on the upper side of ...

... general shape of the body of these fishes, and many other peculiarities, to their habits of life. We should keep in mind, as I have before insisted, that the inherited effects of the increased use of ...

... will thus be preserved, as will those individuals which inherit in the highest degree the effects of the increased and beneficial use of any part. How much to attribute in each particular case to the effects of use, and how much to natural selection, it seems impossible to decide.

I ...

... monkeys has been converted into a wonderfully perfect prehensile organ, and serves as a fifth hand. A reviewer who agrees with Mr. Mivart in every detail, remarks on this structure: "It is impossible to believe that in any number of ages the first slight incipient tendency to grasp could preserve the lives of the individuals possessing it, or favour their chance of having and of rearing offspring." But there is no necessity for any such belief. Habit, and this almost implies that some benefit great or small is thus derived, would in all probability suffice for the work. Brehm saw the young of an African monkey (Cercopithecus) clinging to the under surface of their mother by their hands, and at the same time they ...

... observed that they curled their tails round the branches of a bush placed in the cage, and thus aided themselves in climbing. I have received an analogous account from Dr. Günther, who has seen a mouse thus suspend itself. If the harvest mouse had been more strictly arboreal, it would perhaps have had its tail rendered structurally prehensile, as is the case with some members of the same order. Why Cercopithecus, considering its habits whilst young, has not become thus provided, it would be difficult to say. It is, however, possible that the long tail of this monkey may be of more service to it as a balancing organ in making its prodigious leaps, than as a prehensile organ.

The mammary glands are common to the whole class of mammals, and are indispensable for their existence; they must, therefore, have been developed at an extremely remote period, and we can know nothing positively about their manner of development. Mr. Mivart asks: "Is it conceivable that the young of any animal was ever sa...

... and of its mother? And even if one was so, what chance was there of the perpetuation of such a variation?" But the case is not here put fairly. It is admitted by most evolutionists that mammals are descended from a marsupial form; and if so, the mammary glands will have been at first developed within the marsupial sack. In the case of the fish (Hippocampus) the eggs are hatched, and the young are reared for a time, within a sack of this nature; and an American naturalist, Mr. Lockwood, believes from what he has seen of the development of the young, that they are nourished by a secretion from the cutaneous glands of the sack. Now with the early progenitors of mammals, almost before they deserved to be thus designated, is it not at least possible that the young might have been similarly nourished? And in this case, the individuals which secreted a fluid, in some degree or manner the most nutritious, so as to partake of the nature of milk, would in the long run ...

... glands which are the homologues of the mammary glands, would have been improved or rendered more effective. It accords with the widely extended principle of specialisation, that the glands over a certain space of the sack should have become more highly developed than the remainder; and they

would then ha f rmed a breast but at first witho t n ppl as we see n th O nith hyn chus, t the base f the mammalian nes. Thro tain the in part thro h compensat f growth the ffects f se f nat l selectio

Th d lopm t f th mamm ry gland wo ld l bee f n serv ce, and co ld not h e bee ffected through n tural select n, unl ss the y ung t the sam tim w re able to partak f th secret There is greater d fficulty in und tand g how y ng m m mal ha instincti ely lear t to s ck the breast, than in under tanding h w unhatched ch k ns l a e lear t t break the eg h ll by tapp g ainst it w th th ir pecially ad pted

m th f h h lpl ss, h lf f med off p ing ll th head M M art remarks D d no pecial p isi e ist, th y un e m t n fall bly b h ked by the intru io f th m lk t th indp pe B t th re is special pro- Th larynx is so l g ted th t t rises p to th post e d f the nasal passag and is th nabled t g free t ce t th ai f tl l gs, hil th m lk passe h rm lessl ach id f th lo g ted larynx and so saf ly attain the gull t b l ind t. M M art th asks h w did t al select re- m th ad lt kang roo (d most th r mammals th ass mpt tl t tl y ar d sce ded from a m rs p al f m) th t least perfectl nnocent and harml ss tr t t It may be gg t d ans th t th ce l h is certai ly f h gh impo tance to many an mals, uld l rdly l e bee used th f ll f rce as lo g as tl lary t red th nasal passag d l rof sso Flo has gested t th t th tri t re ld h gre tly in terf red an ai mal ll ing solid food W ll w t rn f sl rt pace t th lo d ions of th an mal kingd m Th Ecl d mata (tar f sh s, se , rch ns, &c.) are f hed w th remarkabl gans, called pedicellariæ hich consi t, wl w ll d l oped, of t dactyl f rceps—th t is, f ne f rmed of three se r ted arms, n atly fitt g tog the and placed o the ummit of a fle ble t m moved by muscles Th s forceps n firmly seize h ld f any bject and Alex d Agassi has s en an Echinu o s urchin r p dly pass g particl s of e rement from forcep to forceps down ce tain l of ts body in rd th t ts hell ho ld n t be f led But there is no d ubt th t b de re m vi d rt f all kinds, they ub er other funct ons a d o of th s apparently d f

g n g f ch st tur s, and h w co ld

tr dactyle forc pses, immo ably fixed t the base, but capabl f a snapping acti n, ce ta n ly exist n som tarfish s and thi intelli g bl if th y serve at l ast in part, as m ans of defence M Agassiz to wh se g t k d n ss I m d bted f m ch inf mat n n the subject nf rm me that there r th r tar fi h s, in wh ch o e of the thre arm f

th h ll i desc bed by M. Perrie as bearing two ki d f ped ell riæ n resembli g th se f Ech us, and th th those f Spatangus and ch case re alw y t restin as fford ing th m ans f ppare tly udde t ansi t s, thro gh tl e abort on of n of th two *kin f an gan*

W th respect to th step by which th se curi rgan h b e ol ed Mr Agas- iz nfers from l wn arch s and th se f Mull th t b tl n ta fi h and a u hins the ped cellar æ must und btedly b look d t as modified pines This m y b inf red from th mann f d l pm t in the i d d l as ll as f m a l g and perfect series

extend even to the manner in which ordinary spines and pedicellariæ with their supporting calcareous rods are articulated to the shell In certain gene a of star fishes the very combinations needed to show that the pedicellariæ are only modified branching spines may be found Thus we have fixed spines with three equi-distant, serrated moveable branches articulated to near their bases and higher up on the same spine three other moveable branches Now when the latter arise from the summit of a spine they form in fact a rude tridactyle pedicellaria and such may be seen on the same spine together with the three lower branches In this case the identity in nature between the arms of the pedicellariæ and the moveable branches of a spine is unmistakable It is generally admitted that the ordinary spines serve as a protection and if so there can be no reason to doubt that those furnished with serrated and moveable branches likewise serve for the same purpo e and they would thus serve still more effectively as soon as by meeting together they acted as a prehensile or snapping apparatus Thus every gradation from an ordinary fixed spine to a fixed pedicellaria would be of service

In certain genera of star fishes these organs instead of being fixed or borne on an immoveable support are placed on the summit of a flexible and muscular though short, stem and in this case they probably subserve some additional function besides defence In the sea urchins the steps can be followed by which a fixed spine becomes articulated to the shell and is thus rendered moveable I wish I had space here to give a fuller abstract of Mr Agassiz s interesting observations on the development of the pedicellariæ All possible gradations as he adds may likewise be found between the pedicellariæ of the star fishes and the hooks of the ophiurians another group of Echinodermata and again between the pedicellariæ of sea urchins and the anchors of the Holothuriæ also belonging to the same great class

a a. ——

ferent species. In their most perfect condition they curiously resemble the head and beak of a vulture in miniature seated on a neck and capable of movement, as is likewise the lower jaw or mandible In one species observed by me all the avicularia on the same branch often moved simultaneously backwards and forwards with the lower jaw widely open through an angle of about 90 in the course of five seconds and their movement caused the whole polyzoary to tremble When the jaws are touched with a needle they seize it so firmly that the branch can thus be haken

Mr Mivart adduces this case chiefly on account of the supposed difficulty of organs, namely the avicularia of the Polyzoa and the pedicellariæ of the Echinodermata, which he

as far as structure is concerned I can see no similarity between tridactyle pedicellariæ and avicularia. The latter resemble somewhat more closely the chelæ or pincers of crustaceans and Mr Mivart might have adduced with equal appropriateness this resemblance as a special difficulty or even their resemblance to the head and beak of a bird The avicularia are believed by Mr Busk Dr Smitt, and Dr Nitsche—naturalists who have carefully stud-

between a zooid and an avicularium. It is therefore impossible to conjecture by what serviceable gradations the one could have been converted into the other but it by no means follows from this that such gradations have not existed

As the chelæ of crustaceans resemble in some degree the avicularia of Polyzoa, both serving as pincers, it may be worth while to show that with the former a long series of serviceable gradations still exists In the first and simplest stage the terminal segment of a limb shuts down either on the square summit of the broad penultimate segment, or against one whole side and is thus enabled to catch hold of an object but the limb still serves as an organ of locomotion We next find one corner of the broad penultimate segment slightly prominent, sometimes furnished with irregular teeth and against these the terminal segment shuts down By an increase in the size of this projection with its shape as well as that of the terminal segment slightly modified and improved, the pincers are rendered more and more perfect until we have at last an instrument as ef

Scent as the chele of a lobster; and all these gradations can be actuall traced.

Besides the vicularia, the Polyzoa possess curious organs called vibracula. These gener ... consist of long bristles, capable of movement and easily excited. In one species examined by me the vibracula were slightl curved and serrated along the out margin and all of them on the same polyzoary oft n moved simultaneousl so that, acting lik long oars, the swept branch rapidly across the object glass of m microscope. When a branch was placed on its face the ibracula becam entangled, and the made violent fforts to free themselves. The are supposed t serv as def nce and ma be seen, as M B sk remarks, "to sweep slo ly and careful the surface of the polyzoary remo ing what might be no ... to the d icate inhabitants of the cells hen their tentacula are protruded." The vicularia, lik the ibracula, probably serv for defence but they also catch and kill small li ing animals, hich t is belie ed are after ard wept b the currents within reach of the tentacula of the zooids. Some species are provided with vicularia and vibracula some th vicularia alone and a few w th vibracula alone.

It is not ea to imagine two objects more ... different in appearance than a bristle or vibraculum, and an vicularium lik the head of a bird yet they are almost certaml homologous and ha been dev loped from the same common source namel zooid with its cell. Hence w can understand how t is that these organs graduate in some cases, as I am informed b M Busk, int each other Thus ith the vicularia of se eral pecies of Lepralia, the moveable mandible is so much produced and is so like b istle that the presence of the upper or fixed beak alone serves to determine even its vicularian nature. Th vibracula may ha been directl d loped from the lips of the ... without ha ing passed through the vicularian stage but t seems more probable that the ha passed through this stage, as during the arly stages of the transformation, the other parts of the cell with the included zooid could hardl ha disappeared t once In many cases the vibracula ha e grooved support at the base which seems to represent the fixed beak though this ... et in some species is quit absent. This ... w of the development of the ibracula, if trustworthy is interesting for supposin that all the species pro ided with vicularia had become extinct, no one with the most vivid imagination would ver have thought that th vibracula had originally xisted as part of an organ, resemblin a bird's head or an irregular box or hood. It is interesting to see two such widely different organs developed from a common origin and as the mo eable lip of th cell serves as a protection to the zooid, there is no difficulty in belie ing that all the gradations, by which the lip becam converted first into th lower mandibl of an vicularium and th n int an lo gated bristle likewise served as a protection in dif erent w s and under different circumstances.

In the vegetable kingdom Mr Mivart only alludes to two cases, namely the structure of the flow rs of orchids, and the mo ments of climbing plants. With respect to the former he says, "Th explanation of their *origin* is deemed thoroughl unsatisfactory— tterly insufficient t xplain the incipient, infinitesimal beginnings of structures which are of utility only when they are considerabl d eloped." As I have fully treated this sub ect in another work, I will here gi e only a f w d tails on one ... of the most striking peculiarities of the flowers of orchids, namel their pollinia. A pollinium when highl de oped consists of a mass of pollen-grains, affixed to an elastic foot stalk or caudicle, and this to a little mass of extrem l viscid matter Th pollinia are by this means transported by insects from one flower to th tigma of another In some orchids there is no caudicle to the pollen masses, and the grains are merel tied together b fine threads but as these are not confined to orchids, the need not here be considered ... t I ma mention that t the base of the orchidaceous series, in *Cypripedium*, w can see h w the threads were probabl first developed. In other orchids the threads coh re t one end of the pollen-masses and this forms the first or nascent trace of a caudicle. That this is the origin of th caudicle even when of considerable length and highly d loped, w ha e good evidence in the aborted pollen-grains which can sometimes be detected mbedded within the central and solid parts.

With respect to the second chief peculiarity namel the little mass of viscid matter attached to the nd of the caudicle, a long series of gradations can be specified, each of plain service to the plant. In most flowers belonging t other orders the stigma secretes little viscid matter N w in certain orchids similar vis-

cid matter is secreted but in much larger quantities by one alone of the three stigmas and this stigma perhaps in consequence of the copious secretion is rendered sterile When an insect visits a flower of this kind it rubs off some of the viscid matter and thus at the same time drags away some of the pollen grains From this simple condition which differs but little from that of a multitude of common flowers there are endless gradations —to species in which the pollen mass terminates in a very short free caudicle —to others in which the caudicle becomes firmly attached to the viscid matter with the sterile stigma itself much modified In this latter case we have a pollinium in its most highly developed and perfect condition He who will carefully examine the flowers of orchids for himself will not deny the existence of the above series of gradations—from a mass of pollen grains merely tied together by threads with the stigma differing but little from that of an ordinary flower to a highly complex pollinium admirably adapted for transportal by insects nor will he deny that all the gradations in the several species are admirably adapted in relation to the general structure of each flower for its fertilisation by different insects In this and in almost every other case the enquiry may be pushed further backwards and it may be asked how did the stigma of an ordinary flower become viscid but as we do not know the full history of any one group of beings it is as useless to ask as it is hopeless to attempt answering such questions

We will now turn to climbing plants These

provided with tendrils In these two latter classes the stems have generally but not always lost the power of twining though they retain the power of revolving which the tendrils likewise possess. The gradations from leaf climbers to tendril bearers are wonderfully close and certain plants may be indifferently placed in either class But in ascending the series from simple twiners to leaf climbers an important quality is added namely sensitiveness to a touch by which means the foot stalks of the leaves or flowers or these modified and converted into tendrils are excited to bend round and clasp the touching object He who will read my memoir on these plants will I think admit that all the many gradations in function and structure between

simple twiners and tendril bearers are in each case beneficial in a high degree to the species. For instance it is clearly a great advantage to a twining plant to become a leaf-climber and it is probable that every twiner which possessed leaves with long foot stalks would have been developed into a leaf-climber if the foot stalks had possessed in any slight degree the requisite sensitiveness to a touch

As twining is the simplest means of ascending a support and forms the basis of our series, it may naturally be asked how did plants acquire this power in an incipient degree afterwards to be improved and increased through natural selection The power of twining depends firstly on the stems whilst young being extremely flexible (but this is a character common to many plants which are not climbers) and secondly on their continually bending to all points of the compass one after the other in succession in the same order By this movement the stems are inclined to all sides, and are made to move round and round As soon as the lower part of a stem strikes against any object and is stopped the upper part still goes on bending and revolving and thus necessarily twines round and up the support The revolving movement ceases after the early growth of each shoot. As in many widely separated families of plants single species and single genera possess the power of revolving and have thus become twiners they must have independently acquired it and cannot have inherited it from

common with plants which did not climb and that this had afforded the basis for natural selection to work on and improve When I made this prediction I knew of only one imperfect case namely of the young flower peduncle of a *Maurandia* which revolved slightly and irregularly like the stems of twining plant but without making any use of this habit Soon afterwards Fritz Müller discovered that the young stems of an *Alisma* and of a *Linum* —plants which do not climb and are widely separated in the natural system —revolved plainly though irregularly and he states that he has reason to suspect that this occurs with some other plants These slight movements appear to be of no service to the plants in question anyhow they are not of the least use in the way of climbing which is the point that concerns us Nevertheless we can see that if the stems of these plants had been flexible and

f nde the co d tio to which they are ex

t l sed tl ro gh nat ral select o u had becom co rted into w ll-de l ped twi g pec s.

W tl respect to the sensit n ss of the foot-talks f th l and fl w and f te drils, arly tl e same rem ks are ppl cabl as n th ase f tl e l g m m ts f tw g plants. As ast mb of pec s, b l g to wid ly dist ct groups, re d ed th tl kind f sens t ss, t gl t t be f nd asce t co d t many pl ts hich h t becom limb Th s the case I bserved tl t th y g fl w pedun les f tl e ab M d rved th msel ittle t ward th de wh as to l ed M rre f d se al spec s f O al th t

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g shak and with l mb g plants t s, as kn w ly d ring th arly tag s f gro th that th foot talks and t drils re sensit

It scarcel possibl tl t th bo l gl t mo m ts, d to t ch l ak th y ung and growing rg ns f pla ts ca b f an l al mportan e t th m B t plants possess, bed ce to n us t n h, pow f mo ment, wh h are f manifest mpo tance to th m f nsta ce to ard and m e ar l from th l gl t.— pposition to, and more arel th d rectio f H tt act n of gr t W tl rves and m scles f an an al are ted by gal ani m by th ab-sorpt f try l th conseq t m e- m ts m y be called an incid tal res lt, f the rves and muscles h not been re d ed specially sen ti to these tim h. So w th plants appears that, from ha ng th pow of m m t obed ence to certai timuli, they are cited in an cid tal mann by touch b be g shak n. H nce th re is n gre t d fficulty admitti g that in th case of leaf-climbers and tendril bearers, t is this

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elect ncomp te t t ac unt f r tl in p t tag of usef l tru t es and I h ve h wn, as I h pe that th re no gre t d ffi ulty th l ad A good pportun ty has th been fforded f r e l gi g a littl g d t s f stru t re ften associ ted with h g d f tion — n mp rta t bject wh ch was n t tr ted ffi nt l gth in U f rm ed t o f th w k I will now b fly cap t lat the f ing cases.

W th th giraff tl co ti ued pre rvation f th d d ls f som t t h gh each g ruminant, wh cl had th l ngest necks, legs, &c. and co ll browse l ttl b the a ag h ght, and th ti ed d truct n f th wl ch co ld n t b wse so h gh w uld h fficed f tl p od ct n f th re markabl q adruped b t tl prol ged se f all th parts tog tl r w th inh ritance w ll ha aided an mpo tant m n r in th co-ordinati n. W th th many insects wh ch m t t bjects, th re is no mp ba-b lity in th b l f that an acc d tal resem blance to som comm bject was ach case th f und t f the w k f natu al selecti since pe fected thro gh the occas al preserv tion of light ri t ns which m de th resemblance t all close and this will h been carried as l g as th insect con tin ed to ary and as lo g as m re and m perfect resemblance led to its escape from

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h gt t, u ... larly rev l g m ht ha been increased and ut lised thro gh nat ral select n, until th y had becom co rted into w ll-de eloped t in spec s.

W th respect to th sensiti ness f the foot talks of th l es and fl w rs, and f t ndrils, n arly the sam rem ks are ppl cabl as in th ase of th re lving m m ts f twi g plants. As ast umbe of spec es, bel g ing to wid ly distin t gro ps, are d wed w th this kind f sens ti ess, it ght t be f und nasce t co dit n many plants hich ha t becom limbers. Thi the case I observ ed th t the ung fl w r ped les of th abo *M ra d* r ved th mselves little t ward th sid wh ch was t hed M rre f nd se ral pecies f *O al* that th l and th ir foot talk m ed pe iall aft xpos re t h t un, wh n th y w re *g tl and repe tedly t ched*, when th plant was shak n. I repeated th se obse t ns som th pec es f *O al* w th th sam result in som f th m th m e-

t ndency wh ch has been tak n advantage of and increased through natural *select on* It is, h w e probabl from reason wh ch I ha e as gned n my m m ir that th s will h oc urred ly with plants wh ch had already ac quired the pow r f re ol ing, and had thus becom twin rs.

I ha already d v ured to xpla n how plants becam twin rs, am ly by the rease f a t nd cy to l ght and regular re l ing m m ts, which w re t first f no se t th m thus m me t, as w ll as that d t a t u h hak b ing the ncide tal res lt f th po f mo ing gained f r oth r and be fi al purposes. Wheth during the gradual d v lopm t f climb g plants, n t ral select on h been aided by th inhe ted ffects f use I w ll n t prete d t decide b t w kn w th t certain period cal *m vem nts* f in tance th so-called leep f plants, are g rned by hab t

hoots and lea f all plants m aft be ng shak and th climbing plants t is, as know ly d ring th early stag s f gro th that th foot talks and t drils are sensit

It is scarcely possibl that th abo l ght mo m ts, d to t ch shak in th ou g and growing rgans f pla ts, can be f any f t nal importa ce t th m B t plants possess, in bed ce to arious t m h, pow rs of mo m t, hich are of mar fest mpo tance to th m f nstance t wards and m re rar l from th l gl t,— ppos tio to, and m re rarel in th d rectio f th ttracti of gra t W th rves and m scles f an animal are ted b gal anism by th ab- sorption f try hnin th conseq t m e- me ts ma be called an incid tal result, f the rves and m scles ha not been rend red specially sensit to these timuli. So w th plant t ppears that, from ha ing th pow of m ment in obed ence to certain timuli, they are cited in an incid tal mann by touch, or b being shak n. H nce th re is n great difficulty in admitting that in the case of leaf-climbers and tendril-bearers, t is this

d tions of tru ture ften associ ted w th ha ged f t ns — mp t nt subject wh h was not treated t uffic t l gth in th f mer ed tions f thi w k. I will n w b fl recap t lat th f reg ing cases.

W th th g raff the co tin ed preser t n f th ind d als f som xtin t h gh reach ing ruminant, h ch had the lo est necks, l gs, &c., and could browse a littl b th era h ght, and th co tin ed destru t n f th se whi h could n t browse so h gh w uld h fficed f th prod tion f this re markabl quadruped b t th prolo ged use f all th parts tog th with inh ritance w ll h aided in an *important mann* in th ir co-ordinati n. W th th many insects which m t te arious objects, th re is no mprob b lity in th beh f that an accid tal resem blance to som comm n bject was in ach case th found t n f th wo k f nat ral selectio since perfected thro gh th occas al preserv tion of slight riat ns which mad th resemblance t all clos and this will ha been carried as l g as the insect con tin ed to ary and as lo g as a m re and m re perfect resemblance led to ts escape from

sharp sighted enemies In certain pecies of whales there is a tendency to the formation of irregular little points of horn on the palate and it seems to be quite within the scope of natural selection to preserve all favourable variations, until the points were converted first into lamellated knobs or teeth like those on the beak of a goose —then into short lamellæ like those of the domestic ducks —and then into lamellæ, as perfect as those of the shoveller-duck —and finally into the gigantic plates of baleen, as in the mouth of the Greenland whale In the family of the ducks the lamellæ are first used as teeth then partly as teeth and partly as a sifting apparatus and at last almost exclusively for this latter purpose

With such structures as the above lamellæ of horn or whalebone habit or use can have done little or nothing as far as we can judge towards their development On the other hand the tran portal of the lower eye of a flat fish to the upper side of the head and the formation of a prehensile tail may be attributed almost wholly to continued use together with inheritance With respect to [illegible]

[illegible] a nutritious fluid and that these glands were improved in function through natural selection and concentrated into a confined area in which case they would have formed a mamma There is no more difficulty in understanding how the branched pines of some ancient echinoderm which served as a defence became developed through natural election into tridactyle pedicellariæ than in understanding the development of th [illegible]

[illegible] for ocomotion In the avicularia and vibracula of the Polyzoa we have organs widely different in appearance developed from the same source and with the vibracula we can understand how the successive gradations might have been of service With the pollinia of orchids the threads which originally served to tie together the pollen grains can be traced cohering into caudicles and the steps can likewise be followed by which viscid matter such as that secreted by the stigmas of ordinary flowers and still subserving nearly but not quite the same purpose, became attached to the free ends of the caudicles —all these gradations being of manifest benefit to the plants in question

With respect to climbing plants, I need not repeat what has been so lately said

It has often been asked if natural selection be so potent, why has not this or that structure been gained by certain species, to which it would apparently have been advantageous But it is unreasonable to expect a precise answer to such questions, considering our ignorance of the past history of each pecies, and of the conditions which at the present day determine its numbers and range In most cases only general reasons but in some few cases special reasons can be assigned Thus to adapt a species to new habits of life many co-ordinated modifications are almost indispensable and it may often have happened that the requisite parts did not vary in the right manner or to the right degree Many species must have been prevented from increasing in numbers through destructive agencies which stood in no relation to certain structures, which we imagine would have been gained through natural selection from appearing to us advantageous to the pecies In this case as the struggle for life did not depend on such structures they could not have been acquired through natural selection In many cases complex and long-enduring conditions often of a peculiar nature are necessary for the development of a structure and the requisite conditions may seldom have concurred The belief that any given structure which we think often erroneously would have been beneficial to a species would have been gained under all circumstances through natural selection is opposed to what we can understand of its manner of action Mr Mivart does not deny that natural selection has effected something but he considers it as demonstrably insufficient to account for the phenomena which I explain by its agency His chief arguments have now been considered and the others will hereafter be considered Th y seem to me to partake little of the character of demonstration and to have little weight in comparison with those in favour of the power of natural selection aided by the other agencies often pecified I am bound to a[illegible] that some of the facts and arguments [illegible] used by me have been advanced for the same purpo[illegible] in an able article lately published in the *Medico-Chi[illegible]gical Review*

At the present day almost all naturalists admit evolution under some form Mr Mivart believes that species change through an internal force or tendency about which it is not pretended that anything is known That

species have capacity for change will be ad mitted by all evolutionists; but there is no need, as it seems to me, to invoke any internal force beyond the tendency to ordinary variability, which through the aid of selection by man has given rise to many well-adapted domestic races, and which through the aid of natural selection would equally well give rise by graduated steps to natural races or species. The final result will generally have been, as already explained, an advance, but in some few cases a retrogression, in organisation.

Mr. Mivart is further inclined to believe, and some naturalists agree with him, that new species manifest themselves "with suddenness and by modifications appearing at once." For instance, he supposes that the differences between the extinct three-toed Hipparion and the horse arose suddenly. He thinks it difficult to believe that the wing of a bird "was developed in any other way than by a comparatively sudden modification of a marked and important kind;" and apparently he would extend the same view to the wings of bats and pterodactyles. This conclusion, which implies great breaks or discontinuity in the series, appears to me improbable in the highest degree.

Every one who believes in slow and gradual evolution, will of course admit that specific changes may have been as abrupt and as great as any single variation which we meet with under nature, or even under domestication. But as species are more variable when domesticated or cultivated than under their natural conditions, it is not probable that such great and abrupt variations have often occurred under nature, as are known occasionally to arise under domestication. Of these latter variations several may be attributed to reversion; and the characters which thus reappear were, it is probable, in many cases at first gained in a gradual manner. A still greater number must be called monstrosities, such as six-fingered men, porcupine men, Ancon sheep, Niata cattle, &c.; and as they are widely different in character from natural species, they throw very little light on our subject. Excluding such cases of abrupt variations, the few which remain would at best constitute, if found in a state of nature, doubtful species, closely related to their parental types.

My reasons for doubting whether natural species have changed as abruptly as have occasionally domestic races, and for entirely disbelieving that they have changed in the wonderful manner indicated by Mr. Mivart, are as follows. According to our experience, abrupt and strongly marked variations occur in our domesticated productions, singly and at rather long intervals of time. If such occurred under nature, they would be liable, as formerly explained, to be lost by accidental causes of destruction and by subsequent intercrossing; and so it is known to be under domestication, unless abrupt variations of this kind are specially preserved and separated by the care of man. Hence in order that a new species should suddenly appear in the manner supposed by Mr. Mivart, it is almost necessary to believe, in opposition to all analogy, that several wonderfully changed individuals appeared simultaneously within the same district. This difficulty, as in the case of unconscious selection by man, is avoided on the theory of gradual evolution, through the preservation of a large number of individuals, which varied more or less in any favourable direction, and of the destruction of a large number which varied in an opposite manner.

That many species have been evolved in an extremely gradual manner, there can hardly be a doubt. The species and even the genera of many large natural families are so closely allied together that it is difficult to distinguish not a few of them. On every continent in proceeding from north to south, from lowland to upland, &c., we meet with a host of closely related or representative species; as we likewise do on certain distinct continents, which we have reason to believe were formerly connected. But in making these and the following remarks, I am compelled to allude to subjects hereafter to be discussed. Look at the many outlying islands round a continent, and see how many of their inhabitants can be raised only to the rank of doubtful species. So it is if we look to past times, and compare the species which have just passed away with those still living within the same areas; or if we compare the fossil species embedded in the sub-stages of the same geological formation. It is indeed manifest that multitudes of species are related in the closest manner to other species that still exist, or have lately existed; and it will hardly be maintained that such species have been developed in an abrupt or sudden manner. Nor should it be forgotten, when we look to the special parts of allied species, instead of to distinct species, that numerous and wonderfully fine gradations can be traced, connecting together widely different structures.

Many large groups of facts are intelligibl

only on the principle that species have been evolved by very small steps for instance the fact that the species included in the larger genera are more closely related to each other and present a greater number of varieties than do the species in the smaller genera The former are also grouped in little clusters like varieties round species and they present other analogies with varieties as was shown in our second chapter On this same principle we can understand how it is that [illegible]

[illegible] degree or manner are more variable than other parts of the same species Many analogous facts all pointing in the same direction could be added

Although very many species have almost certainly been produced by steps not greater than those separating fine varieties yet it may be maintained that some have been developed in a different and abrupt manner Such an admission however ought not to be made without strong evidence being assigned The vague and in some respects false analogies as they have been shown to be by Mr Chauncey Wright which have been advanced in favour of this view such as the sudden crystallisation of inorganic substances or the falling of a facetted spheroid from one facet to another hardly deserve consideration One class of fact however namely the sudden appearance of new and distinct forms of life in our geological formations supports at first sight the belief in abrupt development But the value of this evidence depends entirely on the perfection of the geological record in relation to periods remote in the history of the world If the record is as fragmentary as many geologists strenuously assert there is nothing strange in new forms appearing as if suddenly developed

Unless we admit transformations as prodigious as those advocated by Mr Mivart such as the sudden development of the wings of birds or bats or the sudden conversion of a Hipparion into a horse hardly any light is thrown by the belief in abrupt modifications on the deficiency of connecting links in our geological formations But against the belief in such abrupt changes embryology enters a strong protest It is notorious that the wings of birds and bats and the legs of horses or other quadrupeds are undistinguishable at an early embryonic period and that they become differentiated by insensibly fine steps. Embryological resemblances of all kinds can be accounted for as we shall hereafter see, by the progenitors of our existing species having varied after early youth and having transmitted their newly acquired characters to their offspring at a corresponding age The embryo is thus left almost unaffected and serves as a record of the past condition of the species. Hence it is that existing species during the early stages of their development so often resemble ancient and [illegible]

[illegible] have undergone such momentous and abrupt transformations as those above indicated and yet [illegible]

[illegible] insensibly fine steps

He who believes that some ancient form was transformed suddenly through an internal force or tendency into for in [illegible]

[illegible] be denied that such abrupt and great changes of structure are widely different from those which most species apparently have undergone He will further be compelled to believe that many structures beautifully adapted to all the other parts of the same creature and to the surrounding conditions have been suddenly produced and of such complex and wonderful co-adaptations he will not be able to assign a shadow of an explanation He will be forced to admit that these great and sudden transformations have left no trace of their action on the embryo To admit all this is, as it seems to me to enter into the realms of miracle and to leave those of Science

CHAPTER VIII

INSTINCT

MANY instincts are so wonderful that their development will probably appear to the reader a difficulty sufficient to overthrow my whole theory. I may here premise that I have nothing to do with the origin of the mental powers,

discuss ...

animals of the same class.

I will not attempt any definition of instinct. It would be easy to show that several distinct mental actions are commonly embraced by this term; but every one understands what is meant, when it is said that instinct impels the cuckoo to migrate and to lay her eggs in other birds' nests. An action, which we ourselves require experience to enable us to perform, when performed by an animal, more especially by a very young one, without experience, and when performed by many individuals in the same way, without their knowing for what purpose it is performed, is usually said to be instinctive. But I could show that none of these characters are universal. A little dose of judgment or reason, as Pierre Huber expresses it, often comes into play, even with animals low in the scale of nature.

Frederic Cuvier and several of the older metaphysicians have compared instinct with habit. This comparison gives, I think, an accurate notion of the frame of mind under which an instinctive action is performed, but not necessarily of its origin. How unconsciously many habitual actions are performed, indeed not rarely in direct opposition to our conscious will! Yet they may be modified by the will or reason. Habits easily become associated with other habits, with certain periods of time and states of the body. When once acquired, they often remain constant throughout life. Several other points of resemblance between instincts and habits could be pointed out. As in repeating a well-known song, so in instincts, one action follows another by a sort of rhythm; if a person be interrupted in a song, or in repeating anything by rote, he is generally forced to go back to recover the habitual train of thought: so P. Huber found it was with a caterpillar, which makes a very complicated hammock; for if he took a caterpillar which had completed its hammock up to, say, the sixth stage of construction, and put it into a hammock completed up only to the third stage, the caterpillar simply re-performed the fourth, fifth, and sixth stages of construction. If, however, a caterpillar were

work was already done for it, far from deriving any benefit from this, it was much embarrassed, and, in order to complete its hammock, seemed forced to start from the third stage, where it had left off, and thus tried to complete the already finished work.

If we suppose any habitual action to become inherited—and it can be shown that this does sometimes happen—then the resemblance between what originally was a habit and an instinct becomes so close as not to be distinguished. If Mozart, instead of playing the pianoforte at three years old with wonderfully little practice, had played a tune with no practice at all, he might truly be said to have done so instinctively. But it would be a serious error to suppose that the greater number of instincts have been acquired by habit in one generation, and then transmitted by inheritance to succeeding generations. It can be clearly shown that the most wonderful instincts with which we are acquainted, namely, those of the hive-bee and of many ants, could not possibly have been acquired by habit.

It will be universally admitted that instincts are as important as corporeal structures for the welfare of each species, under its present conditions of life. Under changed conditions of life, it is at least possible that slight modifications of instinct might be profitable to a species; and if it can be shown that instincts do vary ever so little, then I can see no difficulty in natural selection preserving and continually accumulating variations of instinct to any extent that was profitable. It is thus, as I believe, that all the most complex and wonderful instincts have originated. As modifications of corporeal structure arise from, and are increased by, use or habit, and are diminished or lost by disuse, so I do not doubt it has been with instincts. But I believe that

the effects of habit are in many cases of subordinate importance to the effects of the natural selection of what may be called spontaneous variations of instincts—that is of variations produced by the same unknown causes which produce slight deviations of bodily structure

No complex instinct can possibly be produced through natural selection except by the slow and gradual accumulation of numerous slight yet profitable variations Hence as in the case of corporeal structures we ought to find in nature not the actual transitional gradations by which each complex instinct has been acquired—for these could be found only in the lineal ancestors of each species—but we ought to find in the collateral lines of descent some evidence of such gradations or we ought at least to be able to show that gradations of some kind are possible and this we certainly can do I have been surprised to find making allowance for the instincts of animals having been but little observed except in Europe and N

is can be discovered Changes of instinct may sometimes be facilitated by the same species having different instincts at different periods of life or at different seasons of the year or when placed under different circumstances &c in which case either the one or the other instinct might be preserved by natural selection And such instances of diversity of instinct in the same species can be shown to occur in nature

Again as in the case of corporeal structure and conformably to my theory the instinct of each species is good for itself but has never as far as we can judge been produced for the exclusive good of other One of the strongest instances of an animal apparently performing an action for the sole good of another with which I am acquainted is that of aphides voluntarily yielding as was first observed by Huber their sweet excretion to ants that they do so voluntarily the following facts show I removed all the ants from a group of about a dozen aphides on a dock plant, and prevented their attendance during several hours After this interval I felt sure that the aphides would want to excrete I watched them for some time through a lens but not one excreted I then tickled and stroked them with a hair in the same manner as well as I could as the ants do with their antennæ but not one excreted Afterwards I allowed an ant to visit them and it immediately seemed by its eager way of running about to be well aware what a rich flock it had discovered it then began to play with its antennæ on the abdomen first of one aphis and then of another and each as soon as it felt the antennæ immediately lifted up its abdomen and excreted a limpid drop of sweet juice which was eagerly devoured by the ant. Even the quite young aphides behaved in this manner showing that the action was instinctive and not the result of experience It is certain from the observations of Huber that the aphides show no dislike to the ants if the latter be not present they are at last compelled to eject their excretion But as the excretion is extremely viscid it is no doubt a convenience to the aphides to have it removed

performs an action for the exclusive good of another species yet each tries to take advantage of the instincts of others, as each takes advantage of the weaker bodily structure of other species So again instincts cannot be considered as absolutely perfect but as details on this and other such points are not indispensable they may be here passed over

As some degree of variation in instincts under a state of nature and the inheritance of such variations are indispensable for the action of natural selection as many instances as possible ought to be given but want of space prevents me I can only assert that instincts certainly do vary—for instance the migratory instinct both in extent and direction and in its total loss So it is with the nests of birds, which vary partly in dependence on the situations chosen and on the nature and temperature of the country inhabited but often from causes wholly unknown to us Audubon has given several remarkable cases of differences in the nests of the same species in the northern and southern United States Why it has been asked if instinct be variable has it not granted to the bee the ability to use some other material when wax was deficient? But what other natural material could bees use? They will work as I have seen with wax hardened with vermilion or softened with lard Andrew Knight observed that his bees instead of laboriously collecting propolis used a cement of wax and turpentine with which he had covered decorticated trees It has lately been

shown that bees, instead of searching for pollen, will gladly use a very different substance, namely oatmeal. Fear of any particular enemy is certainly an instinctive quality, as may be seen in nestling birds, though it is strengthened by experience, and by the sight of fear of the same enemy in other animals. The fear of man is slowly acquired, as I have elsewhere shown, by the various animals which inhabit desert islands; and we see an instance of this in England, in the greater wildness of all our large birds in comparison with our small birds; for the large birds have been most persecuted by man. We may safely attribute the greater wildness of our large birds to this cause; for in uninhabited islands large birds are not more fearful than small; and the magpie, so wary in England, is tame in Norway, as is the hooded crow in Egypt.

That the mental qualities of animals of the same kind, born in a state of nature, vary much, could be shown by many facts. Several cases could also be adduced of occasional and strange habits in wild animals, which, if advantageous to the species, might have given rise, through natural selection, to new instincts. But I am well aware that these general statements, without the facts in detail, will produce but a feeble effect on the reader's mind. I can only repeat my assurance, that I do not speak without good evidence.

Inherited Changes of Habit or Instinct in Domesticated Animals

The possibility, or even probability, of inherited variations of instinct in a state of nature will be strengthened by briefly considering a few cases under domestication. We shall thus be enabled to see the part which habit and the selection of so-called spontaneous variations have played in modifying the mental qualities of our domestic animals. It is notorious how much domestic animals vary in their mental qualities. With cats, for instance, one naturally takes to catching rats, and another mice, and these tendencies are known to be inherited. One cat, according to Mr. St. John, always brought home game-birds, another hares or rabbits, and another hunted on marshy ground and almost nightly caught woodcocks or snipes. A number of curious and authentic instances could be given of various shades of disposition and of taste, and likewise of the oddest tricks, associated with certain frames of mind or periods of time, being inherited. But let us look to the familiar case of the breeds of the dogs: it cannot be doubted that young pointers (I have myself seen a striking instance) will sometimes point and even back other dogs the very first time that they are taken out; retrieving is certainly in some degree inherited by retrievers; and a tendency to run round, instead of at, a flock of sheep, by shepherd dogs. I cannot see that these actions, performed without experience by the young, and in nearly the same manner by each individual, performed with eager delight by each breed, and without the end being known—for the young pointer can no more know that he points to aid his master, than the white butterfly knows why she lays her eggs on the leaf of the cabbage—

when young and without any training, as soon as it scented its prey, stand motionless like a statue, and then slowly crawl forward with a peculiar gait; and another kind of wolf rushing round, instead of at, a herd of deer, and drive them to a distant point, we should assuredly call these actions instinctive. Domestic instincts, as they may be called, are certainly far less fixed than natural instincts; but they have been acted on by far less rigorous selection, and have been transmitted for an incomparably shorter period, under less fixed conditions of life.

How strongly these domestic instincts, habits, and dispositions are inherited, and how curiously they become mingled, is well shown when different breeds of dogs are crossed. Thus it is known that a cross with a bull-dog has affected for many generations the courage and obstinacy of greyhounds; and a cross with a greyhound has given to a whole family of shepherd-dogs a tendency to hunt hares. These domestic instincts, when thus tested by crossing, resemble natural instincts, which in a like manner become curiously blended together, and for a long period exhibit traces of the instincts of either parent: for example, Le Roy describes a dog, whose great grandfather was a wolf, and this dog showed a trace of its wild parentage only in one way, by not coming in a straight line to his master, when called.

Domestic instincts are sometimes spoken of as actions which have become inherited solely from long-continued and compulsory habit, but this is not true. No one would ever have thought of teaching, or probably could have taught, the tumbler-pigeon to tumble,—an action which, as I have witnessed, is performed

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No complex instinct can possibly be produced through natural selection except by the slow and gradual accumulation of numerous slight yet profitable variations Hence as in the case of corporeal structures we ought to find in nature not the actual transitional gradations by which each complex instinct has been acquired—for these could be found only in the lineal ancestors of each species—but we ought to find in the collateral lines of descent some evidence of such gradations or we ought at least to be able to show that gradations of some kind are possible and this we certainly can do I have been surprised to find making allowance for the instincts of animals having been but little observed except in Europe and North America and for no instinct being known amongst extinct species how very generally gradations leading to the most complex instincts can be discovered Changes of instinct may sometimes be facilitated by the same species having different instincts at different periods of life or at different seasons of the year or when placed under different circumstances &c in which case either the one or the other instinct might be preserved by natural selection And such instances of diversity of instinct in the same species can be shown to occur in nature

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As some degree of variation in instincts under a state of nature and the inheritance of such variation are indispensable for the action of natural selection as many instances as possible ought to be given but want of space prevents me I can only assert that instincts certainly do vary—for instance the migratory instinct both in extent and direction and in its total loss So it is with the nests of birds, which vary partly in dependence on the situations chosen and on the nature and temperature of the country inhabited but often from causes wholly unknown to us Audubon has given several remarkable cases of differences in the nests of the same species in the northern and southern United States Why it has been asked if instinct be variable has it not granted to the bee the ability to use some other material when wax was deficient? But what other natural material could bees use? They will work as I have seen with wax hardened with vermilion or softened with lard Andrew Knight observed that his bees instead of laboriously collecting propolis, used a cement of wax and turpentine with which he had covered decorticated trees. It has lately been

first laid w uld ha to be left fo some tim unincubated th re w ld be ggs and oung birds of diff rent ag s in th same est. If this w re the case the process f la ing and hatching m ght be incon em tly l g more especially as sh m grate at a v ry arly period and th first h tched y g w uld probabl ha to be fed by th male alone. B t th Am rican cuckoo is in this predicament f sh makes h wn nest, and has eggs and ung succes. } h tched all t th sam time. It has bee both asserted and denied that the Am rican cu koo occasi nally her eggs tl b rd ests b t I h ve lat l heard from D M rrell f I wa. that h once found in Illin is ckoo together with a ung y s in th n t of ll } (Garrul erustat) and a. both w re earl f ll f th red th re co ld be mistak in th ir id ntification. I co ll lso g se ral instances of arou bird wh h ha been known occasionall t l y th ir ggs in othe bird nests. N w l t us ppose th t the anci t pro nito of ur European cuckoo had th hab ts of th Am rican ckoo and that sh occasionall laid an in another bird nest. If th old bird profited by this occasi nal hab t thro gh being nabled to migrate earli throu l any th cause or if th youn w re mad m re goro by ad anta being tak of th mistaken instinct of anoth species than when reared by their wn m th encumbered as he could hardly fail to be b ha ing gg and y ung f diff re t age t th sam tim th n th ld bird or

inl ritance th occa io al and aberrant hab t of their moth and their turn w uld be apt to la their eggs in th birds ests, and thus be more successf l in rear g th g. By a contin ed process of th nature I beli that th trang instinct of o cuckoo has been gen rated. It has, also, rece tl been ascertained on suffi t idence b Ad ll M ll that the cuckoo occa ionally la h ggs the bare gro nd sits th m, and feed her young. This rare ent is probabl case of re rsio t the long lost, aboriginal in tinct of id fication.

It has been objected that I ha t noticed othe related instincts and ad ptations of structure th cuckoo, which are poken of as ecessarily co-ordinated. B t in all cases, speculation on an instinct known to us only in a single species, s useless, fo we ha e h th erto had facts to guid us. Until recentl th instin ts of the European and of tl n nparasiti Am rican cuckoo al n were known n w wing to Mr Ramsay s observ ati ns, we h learnt som th g about three Australian species, wh ch lay the ggs n oth b rd n ts. Th chi f points to be ref rred to are three first, th t the comm n cuckoo, with rare xcept ns, la s only gg in nest, so th t th larg and rac ous young b rd rece es ampl food Secondly that th ggs are remarkably small not ceeding those f th skylark,—a b rd bout one fourth as large as th cuckoo Th t th mall size f the egg is a real cause f adaptati n w may infe from the fact of th on paras tic American cuckoo lay ing f ll-sized ggs. Thirdl th t the ng cuckoo soo ft r b rth, has th in tinct the tre gth and a prope ly sh ped back f ject ing its fo t broth rs, hich tl n perish from cold and hunger This has been boldly called a ben fice t arrangement, in rde that th

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Turning n w t tl Au tralian species th gh these bird g ne ally lay nly o gg in nest, t is n t rare to find two o r n three gg in the same nest. In the bro ze cuckoo th g s ary gre tly in size from ght to t n times n length. N w if t had been of an ad antag t thi pecies to have laid gg n mall than those n w laid so as t dece ed certain fost pare ts, or as m re probabl to h been h tched within sh rt period (f t asserted that there is a relatio between th ize of ggs and th period of th ir incubat n) then th re is n difficulty n bel ing th t a ace pecies might ha e bee f rmed which w uld hav laid mall and mall g s for these w uld ha bee m re saf l hatched and reared Mr Ramsa remarks that tw of the Australian cuckoos, wh n they lay their eggs in an pen nest, manifest a decided pref rence f nests co taining gg m lar in colour t their wn. Th ropean speci pparentl manifests som t d cy toward m lar instinct, b t t rarely d parts from t, as is sh wn b h laying h dull and pale-col red eggs in the nest of th Hedge-warble w th bright greenish bl ggs. Had ur uckoo invariabl displayed th abo instinct, t would assuredly ha e been added t those which t is assumed must all hav been ac-

by young birds that have never seen a pigeon tumble We may believe that some one pigeon showed a slight tendency to this strange habit, and that the long-continued selection of the best individuals in successive generations made tumblers what they now are and near Glasgow there are house tumblers as I hear from Mr Brent which cannot fly eighteen inches high without going head over heels It may be doubted whether any one would have thought of training a dog to point had not some one dog naturally shown a tendency in this line and this is known occasionally to happen as I once saw in a pure terrier the act of pointing is probably as many have thought only the exaggerated pause of an animal preparing to spring on its prey When the first tendency to point was once displayed methodical selection and the inherited effects of compulsory training in each successive generation would soon complete the work and unconscious selection is still in progress as each man tries to procure without intending to improve the breed dogs which stand and hunt best On the other hand habit alone in some cases has sufficed hardly any animal is more difficult to tame than the young of the wild rabbit scarcely any animal is tamer than the young of the tame rabbit but I can hardly suppose that domestic rabbits have often been selected for tameness alone so that we must attribute at least the greater part of the inherited change from extreme wildness to extreme tameness to habit and long continued close confinement

Natural instincts are lost under domestication a remarkable instance of this is seen in those breeds of fowls which very rarely or never become broody that is never wish to sit on their eggs Familiarity alone prevents our seeing how largely and how permanently the minds of our domestic animals have been modified It is scarcely possible to doubt that the love of man has become instinctive in the dog All wolves foxes jackals and species of the cat genus when kept tame are most eager to attack poultry sheep and pigs and this tendency has been found incurable in dogs which have been brought home as puppies from countries such as Tierra del Fuego and Australia where the savages do not keep these domestic animals How rarely on the other hand do our civilised dogs even when quite young require to be taught not to attack poultry sheep and pigs! No doubt they occasionally do make an attack and are then

[illegible] On the other hand young chickens have lost wholly by habit that fear of the dog and cat which no doubt was originally instinctive with them for I am informed by Captain Hutton that the young chickens of the parent-stock the *Gallus bankiva*, when reared in India under a hen are at first excessively wild So it is with young pheasants reared in England under a hen It is not that chickens have lost all fear but fear only of dogs and cats for if the hen gives the danger-chuckle they will run (more especially young turkeys) from under her and conceal themselves in the surrounding grass or thickets and this is evidently done for the instinctive purpose of allowing as we see in wild ground birds their mother to fly away But this instinct retained by our chickens has become useless under domestication for the mother hen has almost lost by disuse the power of flight

Hence we may conclude that under domestication instincts have been acquired and natural instincts have been lost partly by habit and partly by man selecting and accumulating during successive generations peculiar mental habits and actions which at first appeared from what we must in our ignorance call an accident. In some cases compulsory habit alone has sufficed to produce inherited mental changes in other cases compulsory habit has done nothing and all has been the result of selection pursued both methodically and unconsciously but in most cases habit and selection have probably concurred

Special Instincts

We shall perhaps best understand how instincts in a state of nature have become modified by selection by con[illegible] cases [illegible] in tinct [illegible] n other [illegible]

[illegible] the Cuckoo —It is supposed by some naturalists that the more immediate cause of the instinct of the cuckoo is that she lays her eggs not daily but at intervals of two or three days so that if she were to make her own nest and sit on her own eggs those

ably be accounted f by the fact f the h ns laying large umber of ggs, b t, as w th the cuckoo, t intervals of t three days. The instinct, how f th Am rican ostrich, as in th case of th M l thrus bonariensis, has not as y t been perfected for surprising number of eggs h trewed ove th plains, so that in d y s hunti I p cked up no less than tw nty lost and wasted eggs.

Many bees are parasitic, and regularly lay their eggs in th nests of othe kinds of bees. This case is m re remarkabl than th t f the cuckoo f these bee ha n t nly had th r instincts b t th ir tructure modified in ac cordance with th ir parasitic hab ts fo th y d t possess th poll n-collecting pparatus which w uld h been ind pensabl if th y had t red p food f th ir wn y ung. Som specie of ph gidæ (wasp-like insects) are likewise parasitic and M. Fabre has lately shown good reaso f bel ing th t, although the *Tachyte gra* gen rally makes ts wn burrow and t res t with paralysed prey fo ts wn larvæ, y t that, wh n this insect finds burrow already mad and t red by anoth sphex, t tak ad antag of the priz and be comes f the occasi n parasitic. In this case as with that of th M lothrus cuckoo, I can see no difficulty in natural selection making an occasional hab t permanent, if f advantag to th species, and if th insect whose est and t red food are f loniously appropriated be not thus t rminated

Slav making nst ct.—This remarkabl in tinct was first disco red in the *F rm ca (Polyerges) ruf scens* by P rre H be bett observ en than his celebrated f th r This ant is absol tel dependent its sla es without th ir aid th species would certainly be com t ct in ingle year The males and f rtil f male d no w k of any kind and th orkers or terile f males, th ugh most en g ti and courageous in aptu ing sla es, do no th w k. They are incapable f making their w nests, or of feedin their wn larvæ. Whe th ld est is found incon nient, and the ha to migrate t is tl sla es which d termine th migration, and actually carry their mast rs th eir j ws. So tt ly h lpless are the mast rs, that when Hube sh t p thirt of th m w thout la b t with plenty of the food hich th lik best, and with their n larvæ and pupæ to tim lat th m to ork, th did nothing they could not en feed themsel s, and man perished of hung Huber then introduced single slave (*F fusca*) and she instantl set to wo k fed and sa ed the surv rs mad som cells and tended the larvæ and put all to rights. What can be more xt aordinary than these well-ascertained facts If w had not kn wn of any th r sla e-making ant, it wo ld h e been hopeless to peculate h w so wonderful an t could ha been perfected

south rn parts ...

F Sm h f th

H be and M Sm th, I tried to pproach the subject in a sceptical frame of mind as any one may well be excused f doubting th istence of so extraordinary an instinct s that f making slaves. Hence, I will giv th observations which I mad in som littl d tail. I opened fourteen nests of *F sa gu nea*, and f und a few sla in all. Males and f rt le females f th sl species (*F fusca*) are f und only in their wn proper communities, and ha ne been observed in th nests of *F sa guinea*. Th sla es are black and not abo e half th size f th ir red masters, so that the

nest is m ch disturbed, and the larvæ and pupæ are exposed th sla es wo k en rg ti cally togeth with their masters in carrying th m w y to place f saf ty Hence, t is cl ar that th sla es feel quit t h me. D ing th m nths f J n and July n three uccess e years, I w tched f many h urs se ral ests in Surrey and Sussex, and ne r saw a lave th l nt a ne t. As, during th se m nths, the sla es are very few in number I tho g t that th y might beha e differentl wl n m re num rous but Mr Sm th informs m that h has w tched th nests t arious hours durin May Ju nd A gust, both in Surre and Hampshire and has n seen th slaves, th ugh present in large numbers in A gust, ther lea ente th nest. Hence h considers th m as trictly h usehold slaves. The mast rs, on th ther hand may be constantly seen bringing in materials f th nest, and food f all kind During th year 1860 h we in the m th of July I cam across a community with an

quired together The eggs of the Australian bronze cuckoo vary according to Mr Ramsay to an extraordinary degree in colour so that in this respect as well as in size natural selection might have secured and fixed any advantageous variation

In the case of the European cuckoo the offspring of the foster parents are commonly ejected from the nest within three days after the cuckoo is hatched and as the latter at this age is in a most helpless condition Mr Gould was formerly inclined to believe that the act of ejection was performed by the foster parents themselves But he has now received a trustworthy account of a young cuckoo which was actually seen whilst still blind and not able even to hold up its own head in the act of ejecting its foster brothers One of these was replaced in the nest by the o[illegible] l was [illegible] neans [illegible] was [illegible] it were of great importance for the young cuckoo as is probably the case to receive as much food as possible soon after birth I can see no special diffic[illegible]

[illegible] or the work of ejection for those young cuckoos which had such habits and structure best developed would be the most securely reared The first step towards the acquisition of the proper instinct might have been more unintentional restlessness on the part of the young bird when somewhat advanced in age and strength the habit having been afterwards improved and transmitted to an earlier age I can see no more difficulty in this than in the unhatched young of other birds acquiring the instinct to break through their own shells —or than in young snakes acquiring in their upper jaws as Owen has remarked a transitory sharp tooth for cutting through the tough egg shell For if each part is liable to individual variations at all ages, and the variations tend to be inherited at a corresponding or earlier age —propositions which cannot be disputed —then the instincts and structure of the young could be slowly modified as surely as those of the adult and both cases must stand or fall together with the whole theory of natural selection

Some species of Molothrus, a widely distinct genus of American birds allied to our starlings, have parasitic habits like those of the cuckoo and the species present an interesting gradation in the perfection of their instincts. The sexes of *Molothrus badius* are stated by an excellent observer Mr Hudson sometimes to live promiscuously together in flocks, and sometimes to pair They either build a nest of their own or seize on one belonging to some other bird occasionally th[illegible] ie nest [illegible] ir eggs [illegible] nough [illegible] They [illegible] sit on their own eggs and rear their own young but Mr Hudson says it is probable that they are occasionally parasitic for he has seen the young of this species following old birds of a distinct kind and clamouring to be fed by them T[illegible]

[illegible] are still far from perfect. This bird is far as it is known invariably lays its eggs in the nests of strangers but it is remarkable that several together sometimes commence to build an irregular untidy nest of their own placed in singularly ill adapted situations as on the leaves of a large thistle They never however as far as Mr Hudson has ascertained complete a nest for themselves They often lay so many eggs—from fifteen to twenty—in the same foster nest, that few or none can possibly be hatched They have moreover the extraordinary habit of pecking holes in the eggs whether of their own species or of their foster parents which they find in the appropriated nests They drop also many eggs on the bare ground which are thus wasted A third species the *M pecoris* of North America has acquired instincts as perfect as those of the cuckoo for it never lays more than one egg in a foster nest so that the young bird is securely reared Mr Hudson is a strong disbeliever in evolution but he appears to have been so much struck by the imperfect instincts of the *Molothrus bonariensis* that he quotes my words and asks, "Must we consider these habits not as especially endowed or created instincts but as small consequences of one general law namely transition?"

Various birds, as has alre[illegible]

[illegible] unite and lay first a few eggs in one nest and then in another and these are hatched by the males. This instinct may prob-

tl r l e and larvæ. So that the masters in this co try rece e muel l ss se ce from thei l es tl an tl y d in S tze land

By wh t step th nstin t f F a g n a riginated I w ll n t prete d to co ject re B t as ants wh ch re n t l e-make s will as I h e seen, carry ff tl p pæ f th r tl red n th ne t t pos-

co ld If th prese ce pro ea se pec wh h had se ed th m—if t w re m re ad antageous to th pec to captur w k rs tl an to procr t th m—tl h b t f col lect p pæ riginally fo food m ght by t al select o b t ngtl ed and n d red permane t fo the ry d ffer nt p rpo f

tio m ght crease and modify tl nsti t— al s pposing ach mod ficatio t b f use to tl pec — t l an ant was f med as abjectly d p d t n t la s as the F rmica ruf ens

C ll-mak g inst ct f the H B —I w ll t h re t min t d tail n thi b-

h ar from m tl m tician th t b ha p ac ti ll sol ed reco d te p bl m d l mad tl cells f tl prope l pe t h ld the gre t t poss bl m t f h w tl the l ast po bl co mpt f prec wax th co truct It has bee rema ked tl k ll l w kman w th fitt g tool nd m as- res, ld fi d t rv d fi lt t mak cell f ax f th tru f rm tl gh th ffected by n d f bee w k g a d k l Grant g wl t ti ts pl ase t see is t first q t co r abl l w th y can mak all tl ecessary gles and pl s, perce h tl ar co rectly mad B t tl d ffculty arl so gre t as t first ppears all th be tif l w k can be sho n, I tl k, t f llow from few mpl in l cts.

I was led to est g t th bject by M W t l se who has sl w that tl f rm f

the cell stand n l e relat on to the presence f adj ning cell and th foll ing v ew m y pe hap b co dered ly as a mod fication f thi theo y Let us look t the gr at prin cipl f g ad t nd s e wl ther N tu e h r m thod of work At

ul r rou ded cell f wax At the tne e u tl se w l a n the cells f the hi e bee placed in a d ble l ye each c ll as i well kn wn, an h xag al prism, w th th bas l edge f ts x d be elled o as to join an d n r m d f three rhombs Tl se

po f th base f th ee adj in g cells n th

t

an

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dome t a,

P re Hube The M l pona itself is inter

f yl d cal cells, n wh ch the young h t hed d n add t on som large lls f w x f r l ld g h n Th e latt c lls are ly ph rical d f n ly eq al a d r ggreg ted int an rregula mass B t th mpo tant point to n t ce s, that th se ells lway mad t th t d g ce f n rn ss to ach tl tl t th y w ld h v inte sect d brok n t each th if the sph l ad been mpl ted b t th s is ne pe m tted ll b es bu lding p f tly flat walls f wax b twee th ph re wh h thu tend t nt ect H ce, ach cell con ts of n out ph ri l port n and f tw three r m re fl t rfaces, accord g as th c ll adj ins t th ee m th r cell When n cell re ts th ee tl cells, wh ch from th ph s l g n ly f tl sam e, is e y f qu t ly and ecessarily tl case th thre fl t faces ar nited nt a pyr m d nd tl s py m d as H b l as rem ked s manif tly gross m tat f tl thr sided py m dal base f th cell f tl e h e-bee A in th ll f tl l l ce so l ll three pane r face any cell ce sar ly t to th constru t f tl ree adj g cells. It is ob

I d ng o a Scotch fir tree twenty five yards distant which they ascended together probably in search of aphides or cocci According to Huber who had ample opportunities for observation the slaves in Switzerland habitually work with their masters in making the nest and they alone open and close the doors in the morning and evening and as Huber expressly states their principal office is to search for aphides This difference in the usual habits of the masters and slaves in the two countries probably depends merely on the slaves being captured in greater numbers in Switzerland than in England

One day I fortunately witnessed a migration of *F sanguinea* from one nest to another and behold aves in em as in the case of *F rufescens* Another day my attention was struck by about a score of the slave makers haunting the same spot and evidently not in search of food they approached and were vigorously repulsed by an independent community of the slave species (*F fusca*) sometimes as many as three of these ants clinging to the legs of the slave making *F sanguinea* The latter ruthlessly killed their small opponents and carried their dead bodies as food to their nest twenty nine yards distant but they were prevented from getting any pupæ to rear as slaves I then dug up a small parcel of the pupæ of *F fusca* from another nest and put them down on a bare spot near the place of combat they were eagerly seized and carried off by the tyrants who perhaps fancied that after all they had been victorious in their late combat

At the same time I laid on the same place a small parcel of the pupæ of another species *F flava* with a few of these little yellow ants still clinging to the fragments of their nest This species is sometimes though rarely made into slaves as has been described by Mr Smith Although so small a species it is very courageous and I have seen it ferociously attack other ants In one instance I found to my surprise an independent community of *F flava* under a stone beneath a nest of the slave making *F sanguinea* and when I had accidentally disturbed both nests the little ant attacked their big neighbours with surprising courage Now I was curious to ascertain whether *F sanguinea* could distinguish the pupæ of *F fusca* which they habitually make into slaves from those of the little and furious *F flava* which they rarely capture and it was evident that they did at once distinguish them for we have seen that they eagerly and instantly seized the pupæ of *F fusca* whereas they were much terrified when they came across the pupæ or even the earth from the nest of *F flava* and quickly ran away but in about a quarter of an hour shortly after all the little yellow ants had crawled away they took heart and carried off the pupæ

One evening I visited another community of *F sanguinea* and found a n

as not a migration) and numerous pupæ I traced a long file of ants burthened with booty for about forty yards back to a very thick clump of heath whence I saw the last individual of *F sanguinea* emerge carrying a pupa but I was not able to find the desolated nest in the thick heath The nest however must have been close at hand for two or three individuals of *F fusca* were rushing d one was ups in its an image

Such are the facts though they did not need confirmation by me in regard to the wonderful instinct of making slaves Let it be observed what a contrast the instinctive habits of *F sanguinea* present with those of the continental *F rufescens* The latter does not build its own nest does not determine its own migrations does not collect food for itself or its young and cannot even feed itself it is absolutely dependent on its numerous slaves *Formica sanguinea* on the other hand possesses much fewer slaves and in the early part of the summer extremely few the masters determine when and where a new nest shall be formed and when they migrate the masters carry the slaves Both in Switzerland and England the slaves seem to have the exclusive care of the larvæ and the masters alone go on slave making expeditions In Switzerland the slaves and masters work together making and bringing materials for the nest both but chiefly the slaves tend and milk as it may be called their aphides and thus both collect food for the community In England the masters alone usually leave the nest to collect building materials and food for themselves,

ated,
alo g
t ce
ridg of ax I som p rts, nly small po tions, m th parts, larg port ns f a homb c pl t were th s left bet een the p-posed bas s, but th wo k, from th un t al tate f th gs had n t bee atly

] thus s cceed d l g fl t plat be-t ee th l as s, by t pp ng w k t the pla es f t nsect

C n id ring h w fl bl th m wax is, I do

topp g th ir w k. In rdinary comb t has ppeared t m th t the bees d ot lw y cceed m w king t xactly t e sam r t from tl pposit sides f I l oticed half-completed h mt t tl base f a j t commenced cell, l l re l gl tly co e e s d here I ppose that the bees had ca ted too q ckly and co n tl e p-posed sid wh re tl bee l ad w ked l ss q kly In ll ma ked nsta c I p t th comb back t tl h a d allowed the bees to g k g f b rt t and agai xam ed tl ell d I f und that the homb plat l ad bee compl ted and had becom *pe f tly flat* it was absol t ly m pos bl f m tl tr m tl inn ss f the little plat that tl y co ld l ffected tl by gna g tl co d an l I pect tl t tl bees in h cases tand pposite les and p sl nd bend th d til and warm wax (hich as I h tried is asily d) into tl prope nt rmediate plan and th flatten t.

From tl peri nt f th ridg f er mba ax an see tl t, f th bees w re t l ld f th sel thin all f w tl co ld mak tl cell f tl proper sl pe by ta ding t th prope d ta ce from ach th b xes t g t tl sam rate, and l nd n g t mak eq al h rical hollo s, l t n allowing tl pheres to break int ach tl w bees, as may be clearl see by xamining th edge f grow ing comb d mak rough circumf re tial wall rim all ro nd tl comb and th y gnaw this w y from th pposit sides, alw ys wo king circularly as they deepen each cell Th y d n t mak the wh le three ided pyra m dal base of any on cell t the same time but only tl t ne rh mb c plate which stands n th e treme gro ing m rgin, or the two plat s, as the case m y be and they n ve complete the uppe edges of the rh mb c pl tes, until the he g nal w lls are com me ced Som of tl se tatem nts differ from those made by th justly cel b ted elder Hub r but I am con ced f the accuracy and if I l ad space I wo ld show th t th y are conf mabl with my theory

H b statem nt that th ery first cell is e cavated out f a l ttl parallel ded wall f wax i not, as far as I h ve seen, tri tly correct tl first comm cement ha ing al w ys bee l ttl l ood of wax but I will n t h re te o d ta ls We see how mpo tant part ca t on pl y in th con truct on f the cells b t t w ld b gr t erro to sup-pose that tl bees cannot build up a ro gh wall f wax n the prope po t n—th t is al g tl plane f intersecti n b tween tw adj m g pheres. I l a eve al pecim n sh wing cl arly that they can d this. Even in th rude circ mf re tial rim wall of wax ro d a grow g comb fle u es may som t mes be bserved co re pond g n po t on to the pla es f th h mb c basal plate of fut re cells. But tl ro gh wall of wax has in ry case to b fi l ed ff by b ing larg ly gnawed a both l s. The manne in whi h tl b b ld urio s they al ays mak tl first ro gh w ll from ten t twenty t mes th k tl n the excess ely thin fin i hed ll f tl cell wh ch w ll ult mately be l ft W hall l tand l w tl y w k by

the masons alw y p ling up the cut w y cem t, and add g fre l cement n the sum mit f tl ridg W shall tl us h a thin wall tead ly gr w g upward but l ays crowned by a gigantic copin From ll the cells, b tl those j t comm ed and those compl ted b ing tl n crowned by a tro g cop g f wax th bee can lust and wl tl comb with t injuri g the d l cate h g nal walls. Th se walls, as Professo M ll has ki dly ascertained fo me, ary gre tly tl kness be g an av g of tw l meas rem t mad near th bord f th comb y g f an inch n thickn ss *wh reas*

is more important labour by this manner of building for the flat walls between the adjoining cells are not double but are of the same thickness as the outer spherical portions and yet each flat portion forms a part of two cells

Reflecting on this case it occurred to me that if the Melipona had made its spheres at some given distance from each other and had made them of equal sizes and had arranged them symmetrically in a double layer the resulting structure would have been as perfect as the comb of the hive bee Accordingly I wrote to Professor Miller of Cambridge and this geometer has kindly read over the following statement drawn up from his information and tells me that it is strictly correct —

If a number of equal

or radius × 1 41421 (or at some lesser distance) from the centres of the six surrounding spheres in the same layer and at the same distance from the centres of the adjoining spheres in the other and parallel layer then if planes of intersection between the several spheres in both layers be formed there will result a double layer of hexagonal prisms united together by pyramidal bases formed of three rhombs and the rhombs and the sides of the hexagonal prisms will have every angle identically the same with the best measurements which have been made of the cells of the hive bee But I hear from Prof Wyman who has made numerous careful measurements that the accuracy of the workmanship of the bee has been greatly exaggerated so much so that whatever the typical form of the cell may be it is rarely if ever realised

Hence we may safely conclude that, if we could slightly modify the instincts already possessed by the Melipona and in themselves not very wonderful this bee would make a structure as wonderfully perfect as that of the hive bee We must suppose that Melipona to have the power of forming her cells truly spherical and of equal sizes and this would not be very surprising seeing that she already does so to a certain extent and seeing what perfectly cylindrical burrows many insects make in wood apparently by turning round on a fixed point. We must suppose the Melipona to arrange her cells in level layers, as she already does her cylindrical cells and we must further suppose and this is the greatest difficulty that she can somehow judge accurately at what distance to stand from her fellow labourers when several are making their spheres but she is already so far enabled to judge of distance that she always describes her spheres so as to intersect to a certain extent and then she unites the points of intersection by perfectly flat surfaces By such modifications of instincts which in themselves are not very wonderful —hardly more wonderful than those which guide a bird to make its nest,— I believe that the hive bee has acquired through natural selection her inimitable architectural powers

But this theory can be tested by experiment. Following the example of Mr Tegetmeier I separated two combs and put between them a long thick rectangular strip of wax the bees instantly began to excavate minute circular pits in it

appearing to the eye perfectly true or parts of a sphere and of about the diameter of a cell It was most interesting to observe that wherever several bees had begun to excavate these basins near together they had begun their work at such a distance from each other that by the time the basins had acquired the above-stated width (i e about the width of an ordinary cell) and were in depth about one sixth of the diameter of the sphere of which they formed a part the rims of the basins intersected or broke into each other As soon as this occurred the bees ceased to excavate and began to build up flat walls of wax on the lines of intersection between the basins so that each hexagonal prism was built upon the scalloped edge of a smooth basin instead of on the straight edges of a three sided pyramid as in the case of ordinary cells

I then put into the hive instead of a thick rectangular piece of wax a thin and narrow knife edged ridge coloured with vermilion The bees instantly began on both sides to excavate little basins near to each other in the same way as before but the ridge of wax was so thin that the bottoms of the basins if they had been excavated to the same depth as in the former experiment would have broken into each other from the opposite sides The bees, however did not suffer this to happen and they stopped their excavations in due time so that the basins, as soon as they had been a little deepened came to have flat bases and these flat bases, formed by thin little plates of the vermilion wax left ungnawed were situ

an country and let s further suppose that the community li ed thro gh th winter and consequently required a store of h ney there can in this case be no d ubt that it would be an ad antag to our imaginary humble-bee if a sl ght modification in h r instincts led her to make her waxen cells near to th so as to intersect a little for a wall in comm n even to tw adjoinin cells w uld sa some little labour and wax. Hence t w uld co tinuall be more and more ad antageous t our humble-bees, if they were to mak their cells m re and more regular neare togeth and aggreg ted int mass, like th cells f th M lipona f in this case large part of th bounding sur face of each cell w uld serv to bound th adjo ning cells, and m ch labour and wax would be sa ed. Again, from th sam cause, t ould be ad antageous to th M lipona, if sh were t mak her cells close tog th r and more regular in ery w y than t present for then, as w ha seen, the sph rical surfaces

natural selection could not lead f th comb of th hi e-bee, as far as w an see, is abso-l tel perfect in eco omising labour and wax.

Thus, as I beli e, the most w nderful of all known instincts, that of th hi -bee can be explained by natural selection havin tak n ad antag of umerous, successi slight mod fications of simple in tincts natural selection ha ing by slow d grees, m re and m re perfectl led the bees to sweep equal spheres at m an distance from each th in d uble la er and to build p and ca ate th wax alon the planes of int rsectio th bees, of co se no more knowing that they swept their spheres at one particular distance from each ther than the kn w what are th se ral angles of the hexagonal prisms and of th basal rhomb ic plates the moti power of the proc ess of nat ral selectio ha ing been th co structio of cells of d stre gth and of the proper size and shape f the larv this bei g ff ted th th gre test possible econom of labou and wax that nd idual arm which th mad the best cells w th least labour and least aste of honey in th secretion of wax, ha ing succeeded best, and h ving transmitted their newly-acquired economical instincts to new warms, which in their turn will ha had the best chance of succeeding in the struggle for existence.

Objections to the Theory of Natural Selec t on as applied to Instincts Neuter and Sterile Insects

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stru
multaneous and ...
oth r as a modificati n in th one with t an immed te correspondin chang in the ther w uld ha e been f tal. Th f rce of this objection rests entirely on the assumptio th t th changes in the instincts and tructure are abrupt. To take as an illustrati n th case f th larger titm use (*Parus maj*) all ded to in pre ious chapter this bird oft n holds the seeds of th yew between ts feet on a branch, and hamm rs with ts beak till t g ts t the kern l. N w what special difficulty w uld th re b in natural selecti n preservin all the sl ght indi id al vari t on in th sh pe of the beak, which w re bett r and better ad pted to break pen th seeds, until a beak was f rmed, as w ll constructed f this purpose as that f the nuthatch, at the sam tim that hab t, o compulsion, spo taneous variati ns of taste led th bird to becom m re and m re of a seed-eater In this case th beak is supposed to be slowly modified by natural selectio sub-

with th beak, from an oth r unkn wn cause and t is n t improbabl that uch larg r feet w uld lead the bird to climb m re and more until t acquired th remarkable climb ng instinct and pow f the th tch In thi case a grad al hang of tru ture is pposed to lead to changed instincts hab ts. T tak on more case f w instincts are more remark abl than that which l ad th swift of th East rn Islands t mak ts nest wholly f in spissated sali a. Som birds build th ir nests of mud beli ved to be m ist ned with sali and of th wifts of N rth Am rica makes ts nest (as I ha see) of ticks aggl tinated with sali a, and ev n with flakes f this sub tance. Is t then ry mprobable th t th natural selectio of individual swifts, which secreted m re and more sali a, hould t la t produce specie with instincts leadin t to neglect ther materials, and to make its nest exclusi ly of n pissated sali a And so in other cases. It must, ho we be admitted that in many instances we cannot co jecture wh ther t was instinct r tructure which first varied.

the basal rhomboidal plates are thicker nearly in the proportion of three to two having a mean thickness from twenty one measurements of $\frac{1}{229}$ of an inch By the above singular manner of building strength is continually given to the comb with the utmost ultimate economy of wax

It seems at first to add to the difficulty of understanding how the cells are made that a multitude of bees all wo ... one bee ... ll going to ... a score of ... individuals work even at the commencement of the first cell I was able practically to show this fact by covering the edges of the hexagonal walls of a single cell or the extreme margin of the circumferential rim of a growing comb with an extremel ... brush—by atoms of the coloured wax having been taken from the spot on which it had been placed and worked into the growing edges of the cells all round The work of construction seems to be a sort of balance struck between many bees all instinctively standing at the same relative distance from each other all trying to sweep equal spheres and then building up or leaving ungnawed the planes of intersection between these spheres It was really curious to note in cases of difficulty as when two pieces of comb met ... ape which they had at first rejected

When bees have a place on which they can stand in their proper positions for working—for instance on a slip of wood placed directly under the middle of a comb growing downwards so that the comb has to be built over one face of the slip—in this case the bees can lay the foundations of one wall of a new hexagon in its strictly proper place projecting beyond the other completed cells It suffices that the bees should be enabled to stand at their proper relative distances from each other and from the walls of the last com ... cell they two ... een ... gles of a cell till a large part both of that cell and of the adjoining cells has been built This capacity in bees of laying do ... under certain circumstances a rough wall in its proper place between two just-commenced cells, is important as it bears on a fact which seems at first subversive of the foregoing theory namely that the cells on the extreme margin of wasp-combs are sometimes strictly hexagonal but I have not space here to enter on this subject Nor does there seem to me any great difficulty in a single insect (as in the case of a queen wasp) making hexagonal cells if she were to work alternately on the inside and outside of two or three cells commenced at the same time always standing at the proper relative distance from the parts of the cells just begun sweeping spheres or cylinders, and building up intermediate planes

As natural selection acts only by the accumulation of slight modifications of structure or instinct each profitable to the individual under its conditions of life it may reasonably be asked how a long and graduated succession of modified architectural instincts all tending towards the present perfect plan of construction could have profited the progenitors of the hive bee? I think the answer is not difficult cells constructed like those of the bee or the wasp gain in strength and save much in labour and space and in the materials of which they are constructed With respect to the formation of wax it is known that bees are often hard pressed to get sufficient nectar and I am informed by Mr Tegetmeier that it has been experimentally proved that from twelve to fifteen pounds of dry sugar are consumed by a hive of bees for the secretion of a pound of wax so that a prodigious quantity of fluid nectar must be collected and consumed by the bees in a hive for the secretion of the wax necessary for the construction of their combs Moreover many bees have to remain idle for many days during the process of secretion A large store of honey is indispensable to support a large stock of bees during the winter and the security of the hive is known mainly to depend on a large number of bees being supported Hence the saving of wax by largely saving honey and the time consumed in collecting the honey must be an important element of success to any family of bees Of course the success of the species may be dependent on the number of its enemies o ... ther a ... all ... to our bumble bees could exist in large numbers in

ants, and the d ble t rile plants w th the pe t rs f th sam comm nity As tl the

tho ... ...

sers ceabl d II ce w m y concl de that l gl t mod ficat ns of truct re r f nstinct corr l ted w th th st ril c d t of certain m mb m f the comm nity h ve proved ad antageo s co seq tly the f tile males and

t m s, u til th t p od g u m nt f d ff ce b twee th fert le d t ril fem les f tl e same spec l as be produced which we see in many soc al insects.

B t w l e t as yet to ched on th acme f tl e d fficulty m ly the fact th t the n t f se al n ts d ff r t o ly from tl f t le f m les and males, b t f m each tl som t mes t an almost in red ble d g ee and are tl di ided to two en thre cast Tl astes, m reo er d t commo ly g d t t ach th b t perf ctly w ll d f d b g as distı t f m ach tl e as ar

... ...

t C yptocerus, the w k l e cast al carry w nd rf l sort f h ld tl l ads, th use f wh l j t nkn t tl M an Myrmecocy t s, tl e o k rs f ast l th t th y ar fed by th k m f anotl cast and th y h n ı m ly d loped bd m al cl cretes sort f h ı ply g tl place f tl t reted by tl ı l id s, tl d mestı catıl as tl y may be called which ur European ants guard and mp ıson.

It ll indeed be th ght th t I h rwee g co fid ce tl prın pl f nat al select n, wl en I d t adm t tl t cl nd rf l and w ll-establıslıed facts t o' w an h lat th theory I th mpl ase of tr nsects all of aste wl h, as I belie ha be re d red d ff re t from th f rt le m l s and f mal tl ro gh nat al se lection, m concl l from th aı al gy f rd ıary ar tıo s, that th uccess l ght, profitable mod fic t ns l d t f rst arise ın all the t rs th sam est l t ın som f w k and that by tl rı l of tl com m t th f mal whıcl prod ced most

ne ters having th ad antageo s modifica t ns, all the ne te s lt mately came to be thu character sed Accord to th s v ew w o l t occas ally to fi d ın tl e s m n st

both larg and mall r num ous, wh l t

and th pec s, as M F S n th has b s ed the l g r w ker l ve mple yes (ocelli) which tho l mall c n b pl ly d t ngu l ed whe as the mall w k s ll ctl r oc lli rudım tary Having caref lly d ssected se l pec m ns f tl se o k s I can affirm th t the y are far more rud m t ry ın the small w rker th n can b accounted f r merely by tl r p po tı nally l sser ıze d I fully b l eve tl gl I dare n l assert so po tı ly that the w k of t med te h tl eir ocell n exactly t rmed t c d t n So tl t l we h tw bodies f t l w kers ın th sam t

ad l g th t f th m ll r w k l ad been tl most usef l t the community and tl o m le and f mal had b n c t ally selected wl ch p od ce l mo e and m f tl m ll w kers, nt l all the work re n tl cond t we hould th ha c l l p c f ant w th ute s ın ly the ame co d t as tl se f Myrm ca I' the w k rs f My m c h v t e rudiment f ocell th gh tl ale and f male ant f th g nu w ll-d l ped ocelli

I m y g th r case so co f de tly d l I pect occas lly to find grad tı ns f m po tant tru t es b t ee the d ffere t cast f n t s m th same pecı th t I gladly ail d myself f Mr F Sm th ff f n m ro pecımens from tl same f th drı ant (A mma) f West Af ca. The read will pe hap best pprecı te th am nt

No doubt many instincts of very difficult explanation could be opposed to the theory of natural selection—cases in which we cannot see how an instinct could have originated cases in which no intermediate gradations are known to exist cases of instincts of such trifling importance that they could hardly have been acted on by natural selection cases of instincts almost identically the same in animals so remote in the scale of nature that we cannot account for their similarity by inheritance from a common progenitor and consequently must believe that they were independently acquired through natural selection I will not here enter on these several cases, but

the neuters or sterile females in insect-communities for these neuters often differ widely in instinct and in structure from both the

great length but I will here take only a single case that of working or sterile ants How the workers have been rendered sterile is a difficulty but not much greater than that of any other striking modification of structure for it can be shown that some insects and other articulate animals in a state of nature occasionally become sterile and if such insects had been social and it had been profitable to the community that a number should have been annually born capable of work but incapable of procreation I can see no especial difficulty in this having been effected through natural selection But I must pass over this preliminary difficulty The great difficulty lies in the working ants differing widely from both the males and the fertile females in structure as in the shape of the thorax and in being destitute of wings and sometimes of eyes and in instinct. As far as instinct alone is concerned the wonderful difference in this respect between the workers and the perfect females would have been better exemplified by the hive bee If a working ant or other neuter insect had been an ordinary animal I should have unhesitatingly assumed that all its characters had been slowly acquired through natural selection namely by individuals having been born with slight profitable modifications which were inherited by the offspring and that these again varied and again were selected and so onwards But with the working ant we have an insect differing greatly from its parents, yet absolutely sterile so that it could never have transmitted successively acquired modifications of structure or instinct to its progeny It may well be asked how is it possible to reconcile this case with the theory of natural selection?

First let it be remembered that we have innumerable instances both in our domestic productions and in those in a state of nature of all sorts of differences of inherited structure which are correlated with certain ages, and with either sex We have differences correlated not only with one sex but with that short period when the reproductive system is active as in the nuptial plumage of many birds, and in the hooked jaws of the male salmon We have even slight differences in the horns of different breeds of cattle in relation to an artificially imperfect state of the male sex for oxen of certain breeds have longer horns than the oxen of other breeds, relatively to the length of the horns in both the bulls and cows of these same breeds. Hence I can see no great difficulty in any character becoming correlated with the sterile condition of certain members of insect communities the difficulty lies in understanding how such correlated modifications of structure could have been slowly accumulated by natural selection

This difficulty though appearing insuperable is lessened or as I believe disappears, when it is remembered that selection may be applied to the family as well as to the individual and may thus gain the desired end Breeders of cattle wish the flesh and fat to be

has succeeded Such faith may be placed in the power of selection that a breed of cattle always yielding oxen with extraordinarily long horns could it is probable, be formed by carefully watching which individual bulls and cows when matched produced oxen with the longest horns and yet no ox would ever have propagated its kind Here is a better and real illustration according to M Verlot, some varieties of the double annual Stock from having been long and carefully selected to the right degree always produce a large proportion of seedlings bearing double and quite sterile flowers but they likewise yield some single and fertile plants. These latter by which alone the variety can be propagated may be compared with the fertile male and female

This theory is also stre gtl e ed by some f f ts regard t instincts as by

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tand the pri cipl of inheritance how t is th t the thrush of trop cal So th Am ca lin est w th m d in the sam pec liar mann as does our British thrush l w t is that the hornb lls f Africa and Ind a h e th sam traordinary nstinct f plastern up and impriso ing th females in a h l in a tree th ly a mall h le l ft th plaster through hich th males feed them and th ir y un when hatched how t is th t th m le wrens (Troglodyte) of No th Am ca bu ld cock nests, to roost in, l k the m le f k tty wrens,— h b t wh lly unlike th t f any oth kn wn b rd Finally t may not be a log cal ded ct but t my imag in t m st is far more satisfact y to look t s h in tincts as the y u uckoo jecting its foste brothers,—ants makin l es,—th lar ae of i hn mon d.e feed g w thin the l bod es of caterp llars,— t as specially n l wed or r ted inst ncts but as small con seq ce f on g n ral law leadi to the ad ancement f all o gan b in s,—namely m lt ply ary l t the tro gest l e and the weake t di

of difference in these workers by my giving not the actual measurements but a strictly accurate illustration the difference was the same as if we were to see a set of workmen building a house of whom many were five feet four inches high and many sixteen feet high but we must in addition suppose that the larger workmen had heads four instead of three times as big as those of the smaller men and jaws nearly five times as big The jaws moreover of the working ... al ... e

... is that though the workers can be grouped into castes of different size yet they graduate insensibly into each other as does the widely different structure of their jaws I speak confidently on this latter point, as Sir J Lubbock made drawings for me with the camera lucida of the jaws which I dissected from the workers of the several sizes Mr Bates in his interesting *Naturalist on the ...ma ons* has described analogous cases

With these facts before me I believe that natural selection by acting on the fertile ants or parents could form a species which should regularly produce neuters all of large size with one form of jaw or all of small size with widely different jaws or lastly and this is the greatest difficulty one set of workers of one size and structure and simultaneously another set of workers of a different size and structure —a graduated series having first been formed as in the case of the driver ant and then the extreme forms having been prod... greater ...val of ...il none ...duced ... given by Mr Wallace of the equally complex case of certain Malayan butterflies regularly appearing under two or even three distinct female forms and by Fritz Müller of certain Brazilian crustaceans likewise appearing under two widely distinct male forms. But this subject need not here be discussed

I have now explained how as I believe the wonderful fact of two distinctly defined castes of sterile workers existing in the same nest, both widely different from each other and from their parents, has originated We can see how useful their production may have been to a social community of ants, on the same principle that the division of labour is useful to civilised man Ants, however work by inherited instincts and by inherited organs or tools whilst man works by acquired knowledge and manufactured instruments. But I must confess that, with all my faith in natural selection I should never have anticipated that this principle could have been efficient in so high a degree had not the case of these neuter insects led me to this conclusion I have, therefore discussed this case at some little but wholly insufficient length in order to show the power of natural selection and likewise because this is by far the most serious special difficulty which my theory has encountered. The case, also is very interesting as it proves that with animals, as with plants, any amount of modification may be effected by the accumulation of numerous, slight, spontaneous variations, which are in any way profitable without exercise or habit having been brought into play For peculiar habits confined to the workers or sterile females however long they might be followed could not possibly affect the males and fertile females which alone leave descendants I am surprised that no one has hitherto advanced this demonstrative case of neuter insects against the well known doctrine of inherited habit, as advanced by Lamarck

Summary

I have endeavoured in this chapter briefly to show that the mental qualities of our domestic animals vary and that the variations are inherited Still more briefly I have attempted to show that instincts vary slightly in a state of nature No one will dispute that instincts are of the highest importance to each animal Therefore there is no real difficulty under changing conditions of life in natural selection accumulating to any extent slight modifications of instinct which are in any way useful. In many cases habit or use and disuse have probably come into play I do not pretend that the facts given in this chapter strengthen in any great degree my theory but none of the cases of difficulty to the best of my judgment, annihilate it On the other hand the fact that instincts are not always absolutely perfect and are liable to mistakes —that no instinct can be shown to have been produced for the good of other animals, though animals take advantage of the instincts of others —that the can... in natural history of *Natura non facit salt...* is applicable to instincts as well as to corporeal structure and is plainly explicable on the foregoing views, but is otherwise inexplicable — all tend to corroborate the theory of natural selection

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ne arr ed at diam trically pposite conclu sions in regard to som of th ery same f rms. It is also most instructi e to compare—b t I h not space here to ent r on d tails—the evid nce ad anced by ou best botanists on the question wh the certain doubtf l f rms should be ranked as pec s ari ties, with the evidence from f rtilit add ced by differ t hybridisers, by the sam observer from experiments mad during diff rent y ars. It can thus be sh wn that th steril ty nor f t affords any certain distinctio between species and arieties. The id nce from this *source graduates* w y, and is d btful n th sam degree as is th idence d ri ed from ther constit tional and tructural diff rences.

In regard to the sterility of h brids in suc cessi generations though Gartn was n abled t rear som h brids, carefully guarding them from cross w th eithe p re parent, for six or se en, and in ne case f t n g n rations, y t he asserts positi el that their fertil ty ne er increases, b t generally decreases greatly and suddenly W th respect t this decrease t may first be noticed that hen any deviation in tructure or const t tio is com *mon to both parents, this often transm tted* in an mented d gree to the offspring, and both sexual elements in h brid plants are already affected in som degree B t I belie that thei fertility has been diminished in nearl all these cases by an independent cause namel by too close interbreeding. I ha mad so many xperime ts and col ected so many facts, showing the one hand that an occasional cross w th distinct ndi idual or ariet increases th vigour and f rtilit of the offspring, and the th hand that ery close interbreeding lessens their gour and f rtility that I cannot doubt the correct ess of this conclusion. H brids are seldom raised b xperimentalists in great mbers and as the parent pecies, or other allied h brids, g erall grow in the sam garden, the visits of insects must be carefully pre ted during the flo ering season hence hybrids, if left t themsel es, d generally be f rtilised during each generation by pollen from the sam flower and this ould probably be injurious to thei fertilit already lessened by their hybrid origin. I am strengthened in this con ction by remark able statement repeatedly mad by Gartn r namel that if en the less f rtile hybrids be artificall f rtilised with hybrid pollen f the m k nd their fertility n twithstandin the

m N w in ... tion, pollen is as often taken by chance (as I know from my wn experi nce) from th an thers of anoth fl w r as from the anth rs of the fl w tself which is to be f rtilised so that cross between two fl w rs, th ugh probably oft n th sam plant, w uld be thus ef fected. M reo when er complicated ex perim nts are in progress, so careful an ob serv as Gartn r w uld have castrated his hybrids, and thus w uld ha ns red in each g ration a cross w th pollen from a distinct fl w r the from the sam plant r from an other plant of th sam hybrid nature And thus, th trange fact f an increase of f rtility in th successi e gen rati ns of *art ficially fertilised* hybrids, in contrast with those spon taneously self fertilised, may as I beli be accounted for by too close interbreeding hav ing been a ided.

N w l t us turn to th results arri ed t by a third most xperi nced h bridiser namel the Hon. and R W Herbert. H is as m phatic in his conclusi that som hybrids are perfectly f rtile—as f rtile as th pure parent *species—as are Kolreut r and Gartn r* that som d gree of sterility between disti ct spe cies is a uni rsal law of nature H xperi mented n som of the v ry sam species as did Gartne Th diff rence in th result may I think, be in part accounted f by Herbert great horticultural skill, and by h s having hot houses t his command. Of his many important tatem nts I will h re gi only a single o e as an exampl nam ly that ry ule in a pod of *Cr m capense* f tilised by *C revolutum* prod ced a plant, which I ne er saw to occur in case of its natural fecundation." So that here w ha e perfect or en more than comm nly perfect f rtility in first cross between two distinct species

This case of th *Cr m* leads m to ref to singular fact, nam ly that indi idual plants *of certain species of Lobelia, Verbascum* and *Passiflora*, can easily be fertilised by pollen from a distinct pecies, b t not by pollen from th sam plant, though this pollen can b pro ed to be perfectly sound by fertilisi other plants or species. In the genus *H ppeastrum*, in *Corydalis* as shown by Professo

CHAPTER IX

HYBRIDISM

THE view commonly entertained by naturalists is that species when intercrossed have been specially endowed with sterility in order to prevent their confusion This view certainly seems at first highly probable for species living together could hardly have been kept distinct had they been capable of freely crossing The subject is in many ways important for us more especially as the sterility of species when first crossed and that of their hybrid offspring cannot have been acquired as I shall show by the preservation of successive profitable degrees of sterility It is an incidental result of differences in the reproductive systems of the parent species

In treating this subject two classes of facts to a large extent fundamentally different have generally been confounded namely the sterility of species when first crossed and the sterility of the hybrids produced from them

Pure species have of course their organs of reproduction in a perfect condition yet when intercrossed they produce either few or no offspring Hybrids on the other hand have their reproductive organs functionally impotent as may be clearly seen in the state of the male element in both plants and animals though the formative organs themselves are perfect in structure as far as the microscope reveals In the first case the two sexual elements which go to form the embryo are perfect in the second case they are either not at all developed or are imperfectly developed This distinction is important, when the cause of the sterility which is common to the two cases has to be considered The distinction probably has been slurred over owing to the sterility in both cases being looked on as a special endowment beyond the province of our reasoning powers

The fertility of varieties that is of the forms known or believed to be descended from common parents, when crossed and likewise the fertility of their mongrel offspring is with reference to my theory of equal importance with the sterility of species for it seems to make a broad and clear distinction between varieties and species.

Degrees of Sterility —First for the sterility of species when crossed and of their hybrid offspring It is impossible to study the several memoirs and works of those two conscientious and admirable observers, Kolreuter and Gärtner who almost devoted their lives to this [illegible]

[illegible] he cuts the knot for in ten cases in which he found two forms considered by most authors as distinct species quite fertile together he unhesitatingly ranks them as varieties. Gartner also makes the rule equally universal and he disputes the entire fertility of Kolreuter s ten cases But in these and in many other cases Gartner is obliged carefully to count the seeds in order to show that there is any degree of sterility He always compares the maximum number of seed produced by two species when first crossed and the maximum produced by their hybrid offspring with the average number produced by both pure parent species in a state of nature But causes of serious error here intervene a plant to be hybridised must be castrated and what is often more important must be secluded in order to prevent pollen being brought to it by insects from other plants Nearly all the plants experimented on by Gartner were potted and were kept in a chamber in his house That these processes are often injurious to the fertility of a plant cannot be doubted for Gartner gives in his table about a score of cases of plants which he castrated and artificially fertilised with their own pollen and (excluding all cases such as the Leguminosæ in which there is an acknowledged difficulty in the manipulation) half of these twenty plants had their fertility in some degree impaired Moreover as Gartner repeatedly crossed some forms such as the common red and blue pimpernels (*Anagallis arvensis* and *coerulea*) which the best botanists rank as varieties and found them absolutely sterile we may doubt whether many species are really so sterile when intercrossed as he believed

It is certain on the one hand that the sterility of various species when crossed is so different in degree and graduates away so insensibly and on the other hand that the fertility of pure species is so easily affected by various circumstances that for all practical

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Hildebrand in various orchids as shown by Mr Scott and Fritz Müller all the individuals are in this peculiar condition So that with some species certain abnormal individuals and in other species all the individuals can actually be hybridised much more readily than they can be fertilised by pollen from the same individual plant[1] To give one instance a bulb of *Hippeastrum aulicum* produced four flowers three were fertilised by Herbert with their own pollen and the fourth was subsequently fertilised by the pollen of a compound hybrid descended from three distinct species the result was that the ovaries of the three first flowers soon ceased to grow and after a few days perished entirely whereas the pod impregnated by the pollen of the hybrid made vigorous growth and rapid progress to maturity and bore good seed which vegetated freely Mr Herbert tried similar experiments during many years and always with the same result These cases serve to show on what slight and mysterious causes the lesser or greater fertility of a species sometimes depends

The practical experiments of horticulturists though not made with scientific precision deserve some notice It is notorious in how complicated a manner the species of *Pelargonium Fuchsia Calceolaria Petunia Rhododendron* &c have been crossed yet many of these hybrids seed freely For instance Herbert asserts that a hybrid from *Calceolaria integrifolia* and *plantaginea* species most widely dissimilar in general habit reproduces itself as perfectly as if it had been a natural species from the mountains of Chili I have taken some pains to ascertain the degree of fertility of some of the complex crosses of rhododendrons and I am assured that many of them are perfectly fertile Mr C Noble for instance informs me that he raises stocks for grafting from a hybrid between *Rhod ponticum* and *catawbiense* and that this hybrid seeds as freely as it is possible to imagine Had hybrids when fairly treated always gone on decreasing in fertility in each successive generation as Gartner believed to be the case the fact would have been notorious to nurserymen Horticulturists raise large beds of the same hybrid and such alone are fairly treated for by insect agency the several individuals are allowed to ... ely ... e of ... one ... ncy of insect agency by examining the flowers of the more sterile kinds of hybrid rhododendrons which produce no pollen for he will find on their stigmas plenty of pollen brought from other flowers

In regard to animals much fewer experiments have been carefully tried th...

... en we may infer that animals more widely distinct in the scale of nature can be crossed more easily than in the case of plants but the hybrids themselves are I think more sterile It should however be borne in mind that owing to few animals breeding freely under confinement few experiments have been fairly tried for instance the canary bird has been crossed with nine distinct species of finches but as not one of these breeds freely in confinement we have no right to expect that the first crosses between them and the canary or that their hybrids should be perfectly f...

... br... have been raised at the same time from different parents so as to avoid the ill effects of close interbreeding On the contrary brothers and sisters have usually been crossed in each successive generation in opposition to the constantly repeated admonition of every breeder And in this case it is not at all surprise...

... well authenticated cases of perfectly fertile hybrid animals I have ...

... perfectly fertile M Quatrefages states that the hybrids from two moths (*Bombyx cynthia* and *arrindia*) were proved in Paris to be fertile inter se for eight generations. It has lately been asserted that two such distinct species as the hare and rabbit when they can be got to breed together produce offspring which are highly fertile when crossed with one of the parent species The hybrids from the common and Chinese geese (... *cygnoides*) species which are so different that they are generally ranked in distinct genera, have often bred in this country with either pure parent, and in one single instance ...

... pure hatch... and from these two

birds h raised n l ss than ght hybrids (grandchildren f th p re geese) from o est. I *India, ho* tl se cross-b ed geese mu t be far m re fert l f I m as. red by t min tly e pabl j dges, nam ly Mr Bl th and Capt. H tton, that wl l flocks of tl ese crossed geese are k pt ar *parts* f l co try and as tl y are k pt f profit l m

acts a

t in man cases tl y ar d see ded from tw *more* ld spec es. From th fact must conclud th that th boriginal pare t pec s t first prod ced pe fectly f rt l hy l nds, r that th hybrid l seq ently reared und r d mest catio b came q t f rtil *This* latt alt rnati wl h as first propo ded b Pallas, seems by far th m t prob bl d an, indeed h rdly be d bted It s, f n ta e almost certain that d g are d sce l d from se al w ld tock y t, w tl pe l ; the t f tai d g us d be d gs f So th A ca, all are q t f rt l t geth b t anal gy makes m gre tl d bt h th th se eral abori al pec s ld t first ha freel l red t g tl and

and commo catt re perfectly f t l and from th bse t m by Rutim th mportant o teolog l d ff re ces, ll as from th se b M Bl tl tl d f f re ce habits, ons t t n, & tl ese t form m t be reg l d as good an l dist ct pecies. Tl sam re k m y be t led t tl tw l f race f tl p g W m t tl ref re tl g p tl bel f f tl sal t rnl t of t wl ro sed must b k t tl is t rnl ty an mals, t as an nd l t le l aract ri t l t as cap- ble of l rem d b l t cat n. F ll co usid g all tl ascert ed facts th t rcross g f plant an l an m ls, it ma be concluded that s d gree f t rnl t both first crosses l l ri ls, an tremel g al res lt l t that t cannt, und prese t t t f k l dge be co sd red as absol t f rsal

Law gove n g tl St l ty f fi t Cros d f H yb d

W ll now co sid l tl re n d tail the la re g tl t rnl t f first crosses

and f h brids. Our cl ef object will be to see wh tl r n t these law ind cat tl pec es h been pecially end wed with this qu l ty m rde t pre ent th r crossing and bl nd t th tt r co fus o Th foll wing co

mals, n ee p
all the sam rules pply t both k ngdoms

It l as been already rema ked th t th de gree f f rt l ty b th f first crosses and f l ybrids, grad te from ro t perfect fe t lity It s rprisi g m h w many curi us w y this grad t n can l e sho b l only

fam l t rts no m e influ nce than so

sam g s, yi ld pe fect g d t on in the n mb r f seed prod ced p to arly com pl t r n qu t compl t f rt lity and as w l see ertain b mal case n to an ee ff t l ty bey nd th t wh ch th plant w pollen rod ces. So n hyb ds th msel s, th re are som wh h r ha p od ced d prob bly n w ld prod ce w th tl poll of tl p re pare t a singl f rt l seed but in som f tl se case a first trace f f rtility m b d tected by th poll f f tl p re p t p e ca g th fl w f tl l b l t w th arl tl an t th rw se w ld l d n and th e ly w tl g f tl fl w w ll kn n to be a gn f e t f rt l sat *From* tl ex

Tl hybrid sed from t pec wh ch re ry diffi lt to cross, and which arely l

which t r pec s, as the g us *l bascum* be ted w th u al facil ty nd rod ce m ro hybrid ff r n g y t tl se l yl rid re mark bly t ril On tl th hand th re re pec h h can be

crossed

... for instance in *Dianthus* these two opposite cases occur

The fertility both of first crosses and of hybrids is more easily affected by unfavourable conditions than is that of pure species But the fertility of first crosses is likewise innately variable for it is not always the same in degree when the same two species are crossed under the same circumstances it depends in part upon the constitution of the individuals which happen to have been chosen for the experiment. So it is with hybrids for their degree of fertility is often found to differ greatly in the several individuals raised from seed out of the same capsule and exposed to the same conditions

... y is meant, the ... ecies in struc ... ertility of first crosses, and of the h ...

... between species ranked by systematists in distinct families and on the other hand by very closely allied species generally uniting with facility But the correspondence between systematic affinity and the facility of crossing is by no means strict A multitude of cases could be given of very closely allied species which will not unite or only with extreme difficulty and on the other hand of very distinct species which unite with the utmost facility In the same family there may be a genus as *Dianthus* in which very many species can most readily be crossed and another genus as *Silene* in which the most persevering efforts have failed to produce between extremely close species a single hybrid Even within the limits of the same genus we meet with this same difference for instance the many species of *Nicotiana* have been more largely crossed than the species of almost any other genus but Gartner found that *N acuminata* which is not a particularly distinct species obstinately failed to fertilise or to be fertilised by no less than eight other species of *Nicotiana* Many analogous facts could be given.

No one has been able to point out what kind or what amount of difference in any recognisable character is sufficient to prevent two species crossing It can be shown that plants most widely different in habit and general appearance and having strongly marked differences in every part of the flower even in the pollen in the fruit and in the cotyledons, can be crossed Annual ...

... tes, can often be crossed with ease

By a reciprocal cross between two species, I mean the case for instance of a female ass being first crossed by a stallion and then a mare by a male ass these two species may then be said to have been reciprocally crossed There is often the widest possible difference in the facility of making reciprocal crosses Such cases are highly important for they prove that the capacity in any two species to cross is often completely independent of their systematic affinity that is of any difference in their structure or constitution excepting in their reproductive systems The diversity of the result in reciprocal crosses between the same two species was long ago observed by Kolreuter To give an instance *Mirabilis jalapa* can easily be fertilised by the pollen of *M longiflora* and the hybrids thus produced are sufficiently fertile but Kolreuter tried more than two hundred times during eight following years to fertilise reciprocally *M longiflora* with the pollen of *M jalapa* and utterly failed Several other equally striking cases could be given Thuret has observed the same fact with certain sea weeds or *Fuci* Gartner moreover found that this difference of facility in making reciprocal crosses is extremely common in a lesser degree He has observed it even between closely related forms (as *Matthiola annua* and *glabra*) which many botanists rank only as varieties It is also a remarkable fact that hybrids raised from reciprocal crosses though of course compounded of the very same two species the one species having first been used as the father and then as the mother though they rarely differ in external character yet generally differ in fertility in a small and occasionally in a high degree

Several other singular rules could be given from Gartner for instance some species have a remarkable power of crossing with other species other species of the same genus have a remarkable power of impressing their likeness on their hybrid offspring but these two powers do not at all necessarily go together There are certain hybrids which ... of having as is usual ...

so th e of their pure parent pec es, re th rare ptions e trem ly t l So agam amon t hybrid wl t re ll int me- diate truct re l tween tl pare ts, e ceptional l t rmal i l ls som tim s are born, l ul l sel resembl of th r p re parent nd tl se l ybrid re al t al tterl t rile n wh tl e th r h t ruls ra sed from seed from tl sa p ule l a co l rabl d gree of f t lity These facts sh w h w compl t l th f rt l ty f a hybrid m y be l pe l t of t t nal resemblance t tl p re p re t

Cons l ri g tl se ral rules w g en, l ubg rn tl f rt l ty f first uses and f h brids, w see th t when f rms, which must be consid red as good and distin t pec s, are ted th f rt l t grad tes from z ro to pe fect f rt lit t f rtil ty d r cer tai cond tio ces tl t tl ei f rtility be les be g m tl scept bl t fa

hybrids prod ced from tl is ross that the f rtil t of h brids t rel ted to tl d gree which th y resembl t rnal ppearance eith parent and la tl tl t th facil ty f making first cros betwe any tw pec es not al rned l tl st mat af fi t d gree f resemblance t ach th Tl latt tat m t cl arly pro ed by th diff renc tl re lt f rec procal crosse bet ee th sam tw pecs, f according

n. Th hybrids, m reo produced from reciprocal crosses ft d ff f rt l t

N w l these compl and ingular rul heat that spec es h bee d ed w th t lt simply t pre t tl becoming con- f led nature I th k not I why sh ll the t rility be so trem l d ff re t m d gree be rious pec es re rossed, al l wl ch m t ppose l ld be eq all mpo tant t keep from ble l g t g th Wl y sl ll the l gree of t ril t be innat ly ariabl tl l iduals ll tl sam pecies Why should som pecies cross w tl facil t and t p luce ry t rile hybrid and th l ries cross w th trem d fficult and y t pro luce fairly f rtil l ybrid Why should there oft be so great diff re ce in th result of reciprocal cross between th same two

peci Wh m y e n be asked has the prod l p bri ls, l diff rent d grees f t ility n t trictly elated to th f cil t of th first uni n between t n re t seem trange arrang m t.

nature, th t, in reciprocal crosses between tw same tw peci s, the mal se al l m nt of m l

ces, and l

th capacity f n pl t to be grafted or b dded n an th is un mportant f r th ir w lf re n tate f n ture I pres me that n ill suppose tl t this capacity is a *pecially* nd wed quality b t will admit th t t is incidental n diff re ce in th laws of growth f tl tw plants. W can som times see th reason why one tree will n t tak n an th from diff rence n th ir rate f growth, in the hardn ss of th wood n th period f th fl w r nature of th ir sap &c. b t multit d of cases we can ass gn n reaso wh t Great d rsity in th ize of two plants, o be g wood and th oth r

l es and th th han l, losely allied pecies, nd an t f th sam pec s, can us all but n t m an bl be grafted w th ase B t this capa t as in hybrid sat n, l y o m ans absol t l g rned b y t m tic affi ty Alth gh man listin t g nera w th n th sam fam l h bee grafted to- g tl in th case spec es f th sam g n w ll not take el th Th pear an be grafted far m re read ly on tl q ince which is anked as a distin t g nus, than n th p- pl wh ch m mbe f th sam g nus. E n d ff rent ar tie f the pear tak w th d f f rent d gree f facility th q ce so do

different varieties of the apricot and peach on certain varieties of the plum

As Gartner found that there was sometimes an innate difference in different *individuals* of the same two species in crossing so Sageret believes this to be the case with different individuals of the same two species in being grafted together As in reciprocal crosses the facility of effecting an union is often very far from equal so it sometime

in difficulty on the gooseberry

We have seen that the sterility of hybrids which have their reproductive organs in an imperfect condition is a different case from

pure species

organs perfect

cases run to a

analogous oc

curs in grafting for Thouin found that three species of *Robinia* which seeded freely on their own roots and which could be grafted with no great difficulty on a fourth species when thus grafted were rendered barren On the other hand certain species of *Sorbus* when grafted on other species yielded twice as much fruit as when on their own roots We are reminded by this latter fact of the extraordinary cases of *Hippeastrum Passiflora* &c which seed much more freely when fertilised with the pollen of a distinct species than when fertilised with pollen from the same plant

We thus see that although there is a clear and great difference between the mere adhesion of grafted stocks and the union of the male and female elements in the act of reproduction yet that there is a rude degree of parallelism in the results of grafting and of crossing distinct species And as we must look at the curious and complex laws governing the facility with which trees can be grafted on each other as incidental on unknown differences in their vegetative systems so I believe that the still more complex laws governing the facility of first crosses are incidental on unknown differences in their reproductive systems These differences in both cases, follow to a certain extent as might have been expected systematic affinity by which term every kind of resemblance and dissimilarity between organic beings is attempted to be expressed The facts by no means seem to indicate that the greater or lesser difficulty of either grafting or crossing various species has been a special endowment although in the case of crossing the difficulty is as important for the endurance and stability of specific forms as in the case of grafting it is unimportant for their welfare

Origin and Causes of the Sterility of first Crosses and of Hybrids

At one time it appeared to me probable as it has to others that the sterility of first crosses and of hybrids might have been slowly acquired through the natural selection of slightly lessened degrees of fertility which, like any other variation spontaneously appeared in certain individuals of one variety when crossed with those of another variety For it would clearly be advantageous to two varieties or incipient species if they could be kept from blending on the same principle that, when man is selecting at the same time two varieties it is necessary that he should keep them separate In the first place it may be remarked that species inhabiting distinct regions are often sterile when crossed now it could clearly have been of no advantage to such separated species to have been rendered mutually sterile and consequently this could not have been effected through natural selection but it may perhaps be argued that if a species was rendered sterile with some one compatriot sterility with other species would follow as a necessary contingency In the second place it is almost as much opposed to the theory of natural selection as to that of special creation that in reciprocal crosses the male element of one form should have been rendered utterly impotent on a second form whilst at the same time the male element of this second form is enabled freely to fertilise the first form for this peculiar state of the reproductive system could hardly have been advantageous to either species

In considering the probability of natural selection having come into action in rendering species mutually sterile the greatest difficulty will be found to be in the existence of many graduated steps from slightly lessened fertility to absolute sterility It may be admitted that it would profit an incipient species if it were rendered in some slight degree sterile when crossed with its parent form or with some other variety for thus fewer bastardised and deteriorated offspring would be produced to commingle their blood with the new species in process of formation But he who will take the trouble to reflect on the steps by which this first degree of sterility could be increased

through nat ral select o to that h gh l gree hich is comm w th so many pecies, a d hich m ersal w th spec s wh h l bee diff re tiated t a g en o f m ly rank, will find th subject traord nar l compl Aft m t re reflect t seems to me that this co ld not h bee ffected thro gh natural selection. Tak tl case f two pecies hich he crossed produced f w and

h l l gree with m t al nf rti t sam l h thus pproached l y mall t p toward l sol t t ril t t an ad ance f this k nd if th theo f natural select n be f t he must l incessa tl oc

sects na

tions tl tri t re d f rtil ty h bee lo ly accum lated b nat al selecti n, from an ad tag h ing bee tl d rectl g en t th communit to hich th y be lo ged tl comm tes f th sam pecies b t an nd dual mal t bel g to soc l omi l f re d red l ghtly sterile h ro sed w tl so tl ar t ld not tl tself g an ad antag ndirectl g an ad antag to th th m d al l of tl sam ariety th leading to the preser ti n.

B t t w ld be perfl us t discuss thi q estio l tail f w th pla ts w l co lu l e that th t rilit f ro sed y m must be d to som pri pl quite ndepend t of t l select Both Gartn and K lr t h pro ed th t g ra m lud m rous pecies, series can be f med from peci which wh crossed y few and f w seeds, t pecies wh l n produce single seed b t t ar affected by the polle f certai th pec es, f th g m w lls. It is t re man festl mpossibl to select th more t rile ind id ls, which h alread ceased to ld seed so tl t th acm of t rilt f tl g rm l ff cted cannot ha bee gained thro gh select and from th law g rn g tl ario grad of teril t he g so f tl gh t the animal a l g t l l k gd ns, m y inf that the use wh t t m be is th sam or nearly th same in all cases.

W w ll now k at l ttle lose t th probable nat re of tl d ff rences bet een speci

wh ch induce terilit in first crosses and in h b ds. In the case of first rosses, the greater l d ffi lt n effect g an n and in bt

se

be

reaching th ut as w

a pla t h a pistil too lo g fo the poll n t b s t ach the o arium It has also been bserved th t wh n the polle f pec e is placed th t gma f a d stantl all ed species, th gh th pollen tubes protrude, they do n t pen t t the t gmat c face Again th mal l ment m y reach the fem l le m t but be i capable of causi g an embry to be de loped as seems to ha been the ase with some f Thu t expe ments on F cu. planat can be gi n f these fact any m re than why certain tree can ot be grafted n others. Lastly an embryo m y b de l ped d th n pe i h ll n arly period This l tt alt t has n t bee ffici ntly tt ded t b t I b li e from b rvations communicated to m by M H tt, who has had gre t peri ce in hybrid g ph asants and fo ls, th t th rly d th f th mb y ry freq t cause of t rility in first crosses. Mr Salt has recently gi en th re

ty f these ggs

maj rity f th f t lised ggs, the mbry had th r been pa t lly d l ped d h d th n

m t l ast t is k wn th t hybrids r sed from ry d tin t pec ar sometimes w ak and d arfed and perish t an ly g f which fact Max W ch a has rece tly g n som triking ase with hyb d will ws. It m be h re w rth t g th t in som cases f parth g esis, th mbry w th n tl g f lk m ths whi h had n t been f tilised pass thro gh th arly tage f de l pm t and th perish lik th mbryos prod ced by ross between d t ct pec es. Until becom g acquainted w th th se f ts, I was unw ll g to bel e e in tl freq nt early

death of hybrid embryos for hybrids when once born are generally healthy and long lived as we see in the case of the common mule Hybrids however ...

... generally placed under suitable conditions of life But a hybrid partakes of only half of the nature and constitution of its mother it may therefore before birth as long as it is nourished within its mother's womb or within the egg or seed produced by the mother be exposed to conditions in some degree unsuitable and consequently be liable to perish at an early period more especially as all very young beings are eminently sensitive to injurious or unnatural conditions of life But after all the cause more probably lies in some imperfection in the ...

... consequently exposed

In regard to the sterility of hybrids in which the sexual elements are ...

... at when animals and plants are removed from their natural conditions they are extremely liable to have their reproductive systems seriously affected This in fact is the great bar to the domestication of animals Between the sterility thus superinduced and that of hybrids there are many points of similarity In both cases the sterility is independent of general health and is often accompanied by excess of size or great luxuriance In both cases the sterility occurs in various degrees in both the male element is the most liable to be affected but sometimes the female more than the male In both the tendency goes to a certain extent with systematic affinity for whole groups of animals and plants are rendered impotent by the same unnatural conditions and whole groups of species tend to produce sterile hybrids On the other hand one spec... ... fertile hybrids No one can tell till he tries, whether any particular animal will breed under confinement, or any exotic plant seed freely under culture nor can he tell till he tries whether any two species of a genus will produce more or less sterile hybrids. Lastly when organic beings are placed during several generations under conditions not natural to them they are extremely liable to vary which seems to be partly due to their reproduct... ...ystems ... So it ...essive ... rations are eminently liable to vary as every experimentalist has observed

Thus we see that when organic beings are placed under new and unnatural conditions, and when hybrids are produced by the unnatural crossing of two species the reproductive system independently of the general state of health is affected in a very similar manner In the one case the conditions of life have been disturbed though often in so slight a degree as to be inappreciable by us in the other case or that of hybrids the external conditions have remained the same but the organisation has been disturbed by two distinct structures and constitutions including of course the reproductive systems having been blended into one For it is scarcely possible that two organisations should be compounded into one without some disturbance occurring in the development, or periodical action or mutual relations of the different parts and organs one to another or to the conditions of life When hybrids are able to breed *inter se* they transmit to their offspring from generation to generation the same compounded organisation and hence we need not be surprised that their sterility though in some degree variable does not diminish it is even apt to increase this being generally the result, as before explained of too close interbreeding The above view of the sterility of hybrids being caused by two constitutions being compounded into one has been strongly maintained by Max Wichura.

It must however be owned that we cannot understand on the above or any other view several facts with respect to the sterility of hybrids for instance the unequal fertility of hybrids produced from reciprocal crosses or the increased sterility in those ...

... explanation is offered why an organism, when placed under unnatural conditions is rendered sterile All that I have attempted to show is that in two cases in some respects allied sterility is the common result —in the one case from the conditions of life having been disturbed in the other case from the organisation having been disturbed by two organisations being compounded into one

A similar parall lism hold good w th a allied y t ry diff rent class of facts. It is an ld and almost uni ersal b h f f unded a considerabl body f v dence wl ch I h e

t bers, &c from e soil climate to an oth r and back again. D ring the con ales ce ce of an mals, gre t benefit is d rived from lmost any chang in tl h b ts f life Again, both w th plants and animals, th re s the lear t d nce that cross bet een in f f f th sam spec es wh ch diff to a

bee bjected t l gl tly d ff re t co d ti ns, l ch ha l gl tl aried gr gour and f rt l t t tl off p g B t, as w l seen, rgan be gs l g l al t ted to certain uni f rm cond t ns nd t t f t wl n bjected as d co fi m t, to consid able chang tl cond ti ns, y freq tly are rend red more less t rıl and w kn w that cross betwee tw f rms, tl t h be come ıd ly pec fically diff re t, prod ce hybrid which are almost alw y in som d gree t rıle I am f lly pers aded tl t th d ble parall l sm by no m ans an acc d t or an ll sion. H w l is abl t plain why th lep1 ant and multitud f th animals are nc pal l of breed g when k pt und nly part al conf m t tl ir natı coun try ll be abl to plain th p mary cause of l b id being so g all t rıl H w ll t the sam t m be l l t pl l w t s th t tl race of som of d t cated an mals, l l l fl bee bject d to w and not f m co d tio is, are q t f t l to getl alth gh tl are d scended from dis t nct pec es, hich ld probably h been t rıl f aborig nally rossed Th bo t parall l series of f ts seem to be connected togetl r y som co m b t known bond h h is esse tially rel ted t tl princ pl of lıf this princi le accord g to Mr Herbert Spencer being that life depends n or consists in the incessant action and react n of ar o s forces, wh ch as through ut n t e, are al w ys te ding t w rd an equilibr um and wh th tend ncy s slightly disturbed by any chang the v tal f rces gain in power

Reciprocal Dimorphism and Trimorphism

This subject may be here bri fly discussed a d will be found t throw some light on hy brid m Se r l pl ts bel ging to d tin t orders p esent tw f ms, whi h exist in ab t eq al numb rs and which diff r in no re pect e cept in th rep odu tive o gans f rm

tam ns in th ize and col ur f the poll n g a s, n l in some tl r re pects and as n ach f th three f rms the are two sets f tam ns, th three f ms possess altog tl er six sets of tam ns an l th ee kinds of p st ls. Th o gans re so propo tioned in l gth t each th that l alf the stam ns in tw f the f m stand a l l with th t gma of th third f m N w I h hown d the re ult has been confi med by ther bserv s th t, i ord to obtain f ll f rt lity w th the e plants, t is necessary th t the st gma of th f rm sh uld be f rtil sed by poll n tak n from the t m ns f co r ponding l ght n anoth fo m So th t with dim r h speci s tw un ns, wh ch m y be called l git mat are f lly f rtile and two wh ch may be called ll git m t are m re less inf rt l W th tr m rphi peci six un ns l gitim t o f lly f rt l —and twel e are ill g timate, m re l ss inf rt l

Th inf rtil ty whi l m y be bserved n ari s d m rpl c and t m rpl pl ts wh n th y are ll g t m t ly f t l sed tl t s by poll tak from tamens n t cor espo d g in h ght w th th p til diff m h d gree up to absol te and tt t l ty j t in th sam mann as occur n ross g d s t ct peci s. As th d g ee f t lity n th l tte case d pe d in an emin t d gree n ll cond tions f lif b ing m re l ss f ur abl so I h f nd t w tl ll gitim te mo s. It is ll kn wn that if poll f d s t ct species be placed o th t gm of fl w er and ts own polle be alte w rds, n afte a consid rable interval f tım placed n the

same stigma its action is so strongly prepotent that it generally annihilates the effect of the foreign pollen so it is with the pollen of the several forms of the same species for legitimate pollen is strongly prepotent over illegitimate pollen when both are placed on the same stigma I ascertained this by fertilising several flowers first illegitimately and twenty four hours afterwards legitimately with the pollen taken from a peculiarly coloured variety and all the seedlings were similarly coloured this shows that the legitimate pollen though applied twenty four hours subsequently had wholly destroyed or prevented the action of the previously applied illegitimate pollen Again as in making reciprocal crosses between the same two species there is occasionally a great difference in the result so the same thing occurs with trimorphic plants for instance the mid styled form of *Lythrum salicaria* was illegitimately fertilised with the greatest ease by pollen from the longer stamens of the short styled form and yielded many seeds but the latter form did not yield a single seed when fertilised by the longer stamens of the mid styled form

In all these respects and in others which might be added the forms of the same undoubted species when illegitimately united behave in exactly the same manner as do two distinct species when crossed This led me carefully to observe during four years many seedlings raised from several illegitimate unions The chief result is that these illegitimate plants as they may be called are not fully fertile It is possible to raise from dimorphic species both long styled and short styled illegitimate plants and from trimorphic plants all three illegitimate forms These can then be properly united in a legitimate manner When this is done there is no apparent reason why they should not yield as many seeds as did their parents when legitimately fertilised But such is not the case They are all infertile in various degrees some being so utterly and incurably sterile that they did not yield during four seasons a single seed or even seed-capsule The sterility of these illegitimate plants when united with each other in a legitimate manner may be strictly compared with that of hybrids when crossed *inter se* If on the other hand a hybrid is crossed with either pure parent species the sterility is usually much lessened and so it is when an illegitimate plant is fertilised by a legitimate plant In the same manner as the sterility of hybrids does not always run parallel with the difficulty of making the first cross between the two parent species, so the sterility of certain illegitimate plants was unusually great whilst the sterility of the union from which they were derived was by no means great With hybrids raised from the same seed capsule the degree of sterility is innately variable so it is in a marked manner with illegitimate plants Lastly many hybrids are profuse and persistent flowerers whilst other and more sterile hybrids produce few

plants

Altogether there is the closest identity in character and behaviour between illegitimate plants and hybrids It is hardly an exaggeration to maintain that illegitimate plants are hybrids produced within the limits of the same species by the improper union of certain forms whilst ordinary hybrids are produced from an improper union between so-called distinct species We have also already seen that there is the closest similarity in all respects between first illegitimate unions and first crosses between distinct species This will perhaps be made more fully apparent by an illustration we may suppose that a botanist found two well marked varieties (and such occur) of the long styled form of the trimorphic *Lythrum salicaria* and that he determined to try by crossing whether they were specifically distinct He would find that they yielded only about one fifth of the proper number of seeds, and that they behaved in all the other above-specified respects as if they had been two distinct species But to make the case sure he would raise plants from his supposed hybridised seed and he would find that the seedlings were miserably dwarfed and utterly sterile and that they behaved in all other respects like ordinary hybrids He might then maintain that he had actually proved in accordance with the common view that his two varieties were as good and as distinct species as any in the world but he would be completely mistaken

The facts now given on dimorphic and trimorphic plants are important because they show us first that the physiological test of lessened fertility both in first crosses and in hybrids is no safe criterion of specific distinction secondly because we may conclude that there is some unknown bond which connects the infertility of illegitimate unions with that

IX

of the r llegt mat ff pring and we are led I t nd tl sa w to first cross d t I

m y differ in no e pect wh tev r tl er in struct re r in const t t n relat ly to x ternal co d tions, and y t b te l wh n ted ce ta n ys. F w m I member that it is the f the se al I m nts f ind d ls f tl e same f rm f i t ce f t lo g t led f rms, wl h lt terl ly wl l t t s tl n f tl e sex al el re t t d t t f rms wh h s

I

it s. it is, really so b t I w ll t nl ge n th s obsc e t ject

We m y l f r as p b ble f m tl cons l tio f d morph c and trim rphi plants, that th t rility f d st t pec h crossed and f th l b d p g y d pends l ly tl n t re f th se al lem nts, nd t a y d ff re ce m th ir tru t re g al const t t n. W ar lso led to this sam co l by co d n g ecprocal crosses, wh ch th m l f pecies an t be ted can be ted w th gre t d fficulty w tl tl f m l f a seco d speci s. I lst tl co rse ross can b ef fected w tl perfect facil ty Th t cell t l sers Ga t l k se co l led tl t sp cie l en rossed re t l w g to l ffe nces co fi ed to tl r reprod ti m t ms

F til ty f Va et es wl en C os ed a d of th M g el Off p ng not t sal

It ma be rged as rwl lm g argu m t tl t tl re must b som sse tial dis t ct let ce pec l t a, as muel as tl l tt l m l tl ma d ff fr m acl tl t n l ppe ce, tl pe fect facil ty and y ld p rfectly f rt l ff pr g W tl som cept s, pres ently be gi I f lly adm t that tl s is th rule It t tl bject rro nded by d ffi l ties, f k k g to n t prod ced und nature, if t f m h th rto rep ted to be arieties be f d any d gree terl to gethe tl are t nce anked l m t na t lists as speci s. For tance th blue and red p mpern l, wh cl are co id red by m t botanists as ar ties, are said by Gärtner to be q te st ril wh n crossed and he ubse qu ntly ranks tl em as u doubted spec e If we tl u argue in a c cl the fert lity f ll v et e produced u d r natu e will ass redly ll e t be g anted

If w turn to ariet produced o s p posed to ha e bee prod d unde d mest t w are t ll n l ed in some doubt

p ana

prob l ly th true o that they are d sce ded f om bo g ally disti I pec s Ne tl el ss tl perfect f rt l ty of so m y d m t race d ff g w d ly from ach oth i appe nce f r tance those f tl e p geon f tl e l b ge a remark bl fact m pec lly wh we reflect how m ny pec s there a wh cl tho gh sembl g ach otl r m t cl cly ar utte ly t il wh te d Se al cons derat s how rende tl e f rtil tv f d me t c ri et es les emark ble In th first place t m y b bse ed tl t tl m nt of external dif f re ce b t n tw pec i u guid to

ted pl t h be n s bjected h ve h d l ttl te d cy towards modify g th repro d t y t m in man leading t mutual steril ty th t w ha good ground f ad m tt g tl d ectly ppo t doct n f Pallas am ly th t h c d t ns ge ally el min te th t nd y so tl t tl d me ticated d sce d ts f pec wh h in tl n tu al tate p b bly ld ha e been in som d gree t l wl n e ssed becom perfectly f tile t g th W tl plants, so f lti t n from g ng a tend y toward t ril ty be twee disti ct pe s, tl l n se eral well ll t cated case lready ll ded to certa n

thro gh lo g-contin ed d mest cat on b ad

same stigma its action is so strongly prepotent that it generally annihilates the effect of the foreign pollen so it is with the pollen of the several forms of the same species for legitimate pollen is strongly prepotent over illegitimate pollen when both are placed on the same stigma I ascertained th g

... at seedlings were similarly coloured this shows that the legitimate pollen though applied twenty four hours subsequently had wholly destroyed or prevented the action of the previously applied illegitimate pollen Again as in making reciprocal crosses between the same two species there is occasionally a great difference in the result so the same thing occurs with trimorphic plants for instance the mid styled form of *Lythrum salicaria* was illegitimately fertilised with the greatest ease by pollen from the longer sta

and yielded did not yield ne longer stamens of the mid styled form

In all these respects and in others which might be added the forms of the same undoubted species when illegitimately united behave in exactly the same manner as do two distinct species when crossed This led me carefully to observe during four years many seedlings raised from several illegitimate unions The chief result is that these illegitimate plants as they may be called are not fully fertile It is possible to raise from dimorphic species both long styled and short styled illegitimate plants and from trimorphic plants all three illegitimate forms These can then be properly united in a legitimate manner When this is done there is no apparent reason why th

various degrees some being so utterly and incurably sterile that they did not yield during four seasons a single seed or even seed capsule The sterility of these illegitimate plants when united with each other in a legitimate manner may be strictly compared with that of hybrids when crossed *inter se* If on the other hand a hybrid is crossed with either pure parent species the sterility is usually much lessened and so it is when an illegitimate plant is fertilised by a legitimate plant In the same manner as the sterility of hybrids does not always run parallel with the difficulty of making the first cross between the two parent species, so the sterility of certain illegitimate plants was unusually great whilst the sterility of the union from which they were derived was by no means great With hybrids raised from the same seed capsule the degree of sterility is innately variable so it is in a marked manner with illegitimate plants Lastly many hybrids are profuse and persistent flowerers, whilst other and more sterile hybrids produce few flo

plants

Altogether there is the closest identity in character and behaviour between illegitimate plants and hybrids It is hardly an exaggeration to maintain that illegitimate plants are hybrids produced within the limits of the same species by the improper union of certain forms whilst ordinary hybrids are produced from an improper union between so-called distinct species We have also already seen that there is the closest similarity in all respects between first illegitimate unions and first

two well marked varieties (and such occur) of the long styled form of the trimorphic *Lythrum salicaria* and that he determined to try by crossing whether they were specifically distinct. He would find that they yielded only about one fifth of the proper number of seeds and that they behaved in all the other above-specified respects as if they had been two distinct species But to make the case sure he would raise plants from his supposed hybridised seed and he would find that the seedlings were miserably dwarfed and utterly sterile and that they behaved in all other respects like ordinary hybrids He might then maintain that he had actually proved in accordance with the common view that his two varieties were as good and as distinct species as any in the world but he would be completely mistaken

The facts now given on dimorphic and trimorphic plants are important because they show us first that the physiological t f lessened fertility both in first crosses and in hybrids is no safe criterion of specific distinction secondly because we may conclude that there is some unknown bond which connects the infertility of illegitimate unions with that

reputed to be varieties, and which he tested by the most trustworthy test, namely by reciprocal crosses, and he found their mongrel offspring perfectly fertile. But one of these five varieties, when used either as the father or mother and crossed with the Nicotiana glutinosa, always yielded hybrids not so sterile as those which were produced from the four other varieties when crossed with N. glutinosa. Hence the reproductive system of this one variety must have been in some manner and in some degree modified.

From these facts it can no longer be maintained that varieties when crossed are invariably quite fertile. From the great difficulty of ascertaining the infertility of varieties in a state of nature, for a supposed variety if proved to be infertile in any degree, would almost universally be ranked as a species — from man attending only to external characters in his domestic varieties, and from such varieties not having been exposed for very long periods to uniform conditions of life — from these several considerations we may conclude that fertility does not constitute a fundamental distinction between varieties and species when crossed. The general sterility of crossed species may safely be looked at, not as a special acquirement or endowment, but as incidental on changes of an unknown nature in their sexual elements.

Hybrids and Mongrels compared independently of their fertility

Independently of the question of fertility the offspring of species and of varieties when crossed may be compared in several other respects. Gartner, whose strong wish it was to draw a distinct line between species and varieties, could find very few, and, as it seems to me, quite unimportant differences between the so-called hybrid offspring of species, and the so-called mongrel offspring of varieties. And, on the other hand, they agree most closely in many important respects.

I shall here discuss this subject with extreme brevity. The most important distinction is, that in the first generation mongrels are more variable than hybrids; but Gartner admits that hybrids from species which have long been cultivated are often variable in the first generation; and I have myself seen striking instances of this fact. Gartner further admits that hybrids between very closely allied species are more variable than those from very distinct species; and this shows that the difference in the degree of variability graduates away. When mongrels and the more fertile hybrids are propagated for several generations, an extreme amount of variability in the offspring in both cases is notorious; but some few instances of both hybrids and mongrels long retaining a uniform character could be given. The variability, however, in the successive generations of mongrels is, perhaps, greater than in hybrids.

This greater variability in mongrels than in hybrids does not seem at all surprising. For the parents of mongrels are varieties, and mostly domestic varieties (very few experiments having been tried on natural varieties), and this implies that there has been recent variability, which would often continue and would augment that arising from the act of crossing. The slight variability of hybrids in the first generation, in contrast with that in the succeeding generations, is a curious fact and deserves attention. For it bears on the view which I have taken of one of the causes of ordinary variability; namely, that the reproductive system from being eminently sensitive to changed conditions of life, fails under these circumstances to perform its proper function of producing offspring closely similar in all respects to the parent-form. Now hybrids in the first generation are descended from species (excluding those long-cultivated) which have not had their reproductive systems in any way affected, and they are not variable; but hybrids themselves have their reproductive systems seriously affected, and their descendants are highly variable.

But to return to our comparison of mongrels and hybrids: Gartner states that mongrels are more liable than hybrids to revert to either parent-form; but this, if it be true, is certainly only a difference in degree. Moreover, Gartner expressly states that hybrids from long cultivated plants are more subject to reversion than hybrids from species in their natural state; and this probably explains the singular difference in the results arrived at by different observers: thus Max Wichura doubts whether hybrids ever revert to their parent-forms, and he experimented on uncultivated species of willows; whilst Naudin, on the other hand, insists in the strongest terms on the almost universal tendency to reversion in hybrids, and he experimented chiefly on cultivated plants. Gartner further states that when any two species, although most closely allied to each other, are crossed with a third species, the hybrids

cases with species having a peculiar constitution sterility might occasionally be thus caused Thus as I believe we can understand why with domesticated animals varieties have not been produced which are mutually sterile and why with plants only a few such cases immediately to be given have been observed

The real difficulty in our present subject is not, as it appears to me why domestic varieties have not become mutually infertile when crossed but why this has so generally occurred with natural varieties as soon as they have been permanently modified in a sufficient degree to take rank as species We are far from precisely knowing the cause nor is this surprising seeing how profoundly ignorant we are in regard to the normal and abnormal action of the reproductive system But we can see that species owing to their struggle for existence with numerous competitors will have been exposed during long periods of time to more uniform conditions than have domestic varieties and this may well make a wide difference in the result. For we know how commonly wild animals and plants when taken from their natural conditions and subjected to captivity are rendered sterile and the reproductive functions of organic beings which have always lived under natural conditions would probably in like manner be eminently sensitive to the influence of an unnatural cross Domesticated productions on the other hand which as shown by the mere fact of their domestication were not originally highly sensitive to changes in their conditions of life and which can now generally resist with undiminished fertility repeated changes of conditions might be expected to produce varieties which would be little liable to have their reproductive powers injuriously affected by the act of crossing with other varieties which had originated in a like manner

I have not as yet spoken as if the varieties of the same species were invariably fertile when intercrossed But it is impossible to resist the evidence of the existence of a certain amount of sterility in the few following cases, which I will briefly abstract. The evidence is at least as good as that from which we believe in the sterility of a multitude of species The evidence is, also derived from hostile witnesses, who in all other cases consider fertility and sterility as safe criterions of specific distinction Gartner kept during several years a dwarf kind of maize with yellow seeds and a tall variety with red seeds growing near each other in his garden and although these plants have separated sexes they never naturally crossed He then fertilised thirteen flowers of the one kind with pollen of the other but only a single head produced any seed and this one head produced only five grains Manipulation in this case could not have been injurious, as the plants have separated sexes No one I believe has suspected that these varieties of maize are distinct species and it is important to notice that the hybrid plants thus raised were themselves *perfectly* fertile so that even Gartner did not venture to consider the two varieties as specifically distinct

Girou de Buzareingues crossed three varieties of gourd which like the maize has separated sexes and he asserts that their mutual fertilization is by so much the less easy as their differences are greater How far these experiments may be trusted I know not but the forms experimented on are ranked by Sageret, who mainly founds his classification by the test of infertility as varieties, and Naudin has come to the same conclusion

The following case is far more remarkable, and seems at first incredible but it is the result of an astonishing number of experiments made during many years on nine species of Ver

seed than the similarly coloured varieties of the same species Moreover he asserts that, when yellow and white varieties of one species are crossed with yellow and white varieties of a *distinct* species more seed is produced by the crosses between the similarly coloured flowers, than between those which are differently coloured Mr Scott also has experimented on the species and varieties of *Verbascum* and although unable to confirm Gartner s results on the crossing of the distinct species he finds that the dissimilarly coloured varieties of the same species yield fewer seeds in the proportion of 86 to 100 than the similarly coloured varieties Yet these varieties differ in no respect except in the colour of their flowers and one variety can sometimes be raised from the seed of another

Kolreuter whose accuracy has been confirmed by every subsequent observer has proved the remarkable fact that one particular variety of the common tobacco was more fertile than the other varieties when crossed with a widely distinct species He experimented on five forms which are commonly

reprod cti e sy t ms. Th re is no m re ason t think that specie h v bee spec ally n dowed th an d gree f t ril ty to p e- t th cross nd bl d g m nature tl an t th k that tree l l een spec lly

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ur f re ts.

Tle t nl ty f first rosses and f th hy brid prog y has n t bee acq red tl ro gh tural select n. I th case f f rst crosse it seems to depe d se al re mstan es in som nstance l f p rt tl early d tl of the mbry I th case f hybr ds, it p- pare tly d pe d th h l gamsat l m bee lust bed by b g compo ded from t dist t form tl t nl ty b ing losel ll ed t tl t wh cl so freq tly f fect p re pec es, wl exposed to w and u nat ral cond t s f l f ll wh will plai tl se latt cases ll b bl t j l n tl t nl ty f l y b ds. Th s m tro gly pport d b parall lism f oth kind nam ly th t, firstly l gl t cl ang th co d t ns f l f add to tl g d f rt l ty of all gan be gs and seco dly tl t tl cross f f ıs, wl ich l b posed t sl ghtly d ff re t co l t f l f wl h h ar d f rs tl g and f tilt f tl e ff p g Tl facts g tl t nl ty f tl ll g t m t ns f d m rpl nd t ri l ic pla ts and f th ll g t m t l g t lag re d t probabl th t som kno bond all case o ects tl d gree of f til t f first unions w th tl t f th ff r g. Tl t f tl se fact di torg b n, as ll as f th re lts f re ciprocal ro se l l l ad t tl co l that tl ar ca se f tl t l ty f cross l pec co f ed t d ff ce in tl l l ts. B t n tl ase f d t t pec es tl se al l ts so ld so g all l been m m re l ss mod fed lead t tl t al f rtil t w l t k l t t sev t ta l som k se re l l t pec es l g bee posed f l g

p r od of t m to nearly uniform cond t ns of life

It n t urp s g th t th diffi ulty in cro g any t o pecies, and th ter lity f

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tween th pec s wh ch are cr sed N s t s rp g that the fac l ty f ffecting a fi t cross, *d tl f rt lity f th hybrid thu pro-* d ced and th cap c ty of bein grafted to- g th r tl o gh th l tt c pac ty e d tly d p d w d h d ff rent circ m tanc — hould all run l a rt n e t t, p all l w th the s t m t affin ty f the f rms b jected to xpe m t f y tem t c ffinity s l d s re mblance of all k ds.

F rst cros b twee fo m known t b var t or fficiently l ke t b cons d ed as n tie d the m ngrel ff p ng ery g ally b t n t, as so ften tated i arı bly fe til N is th alm t uni ersal and perfect fe t l ty urp ng when t m mbered h w l bl we re to argue n a *rcle w th re pect to ariet s in state of* t re and wh n rem mbe th t th gr ter n mb r of t l b n produced und r d me t cat n by th select n f mere e te nal d ff ren d th t th y h v not been l g posed t f m ond t n f lif It l ld lso b pec lly k pt in mind tl t l g-co t ed l m t t t d to l n n te terility and th f re l ttl lik ly t d ce th s sam qual ty Ind pendently f tl q t f f t l ty n ll oth respect th re is th l se t g al resembl ce between l y b d and m b in tl variab l ty in th pow f also bing each othe by re pe ted se d in tl inher tan f harα t from both p ent f rms. F n lly tl altl gl w re as g ant of the p cise ca se *f th t l ty* f first crosses and f hyt id as w re l y m ls and plant rem ed from th natur l co d ti s b com t ril t tl facts g en in this ch pt d t se t m pposed t th bel f th t pec bo g ally ted as a t es

whereas
cies are
crossed with another species the hybrids do not differ much But this conclusion as far as I can make out, is founded on a single experiment and seems directly opposed to the results of several experiments made by Kolreuter

Such alone are the unimportant differences which Gartner is able to point out between hybrid and mongrel plants On the other hand the degrees and kinds of

s follow according to Gartner the same laws When two species are crossed one has sometimes a prepotent power of impressing its likeness on the hybrid So I believe it to be with varieties of plants and with animal one variety certainly often has this prepotent power over anot

mongrel plants from a reciprocal cross Both hybrids and mongrels can be reduced to either pure parent form by repeated crosses in successive generations with either parent.

These several remarks are apparently applicable to animals but the subject is here much complicated partly owing to the existence of secondary sexual characters but more especially owing to prepotency in transmitting likeness running more strongly in one sex than in the other both when one species is crossed with another and when one variety is crossed with another variety For instance I think those authors are right who maintain that the ass has a prepotent power over the horse so that both the mule and the hinny resemble more closely the ass than the horse but that the prepotency runs more strongly in the male than in the female ass, so that the mule which is the offspring of the male is
is

ress has been laid by some authors on the supposed fact that it is only with mongrels that the offspring are not intermediate in character but closely resemble one of their parents but this does sometimes occur with hybrids yet I grant much less frequently than with mongrels Looking to the cases which I have collected of cross-bred animals closely resembling one parent the resemblances seem chiefly confined to characters almost monstrous in their nature and which have suddenly appeared—such as albinism melanism deficiency of tail or horns, or additional fingers and toes and do not relate to characters which have been slowly acquired through selection A tendency to sudden reversions to the perfect character of either parent would also be much more likely to occur with mongrels which are descended from varieties often suddenly produced and semi-monstrous in character than with hybrids, which are descended from species slowly and naturally produced On the whole I entirely agree with Dr Prosper Lucas, who after arranging an enormous body of facts with respect to animals comes to the conclusion that the laws of resemblance of the child to its parents are the same whether the two parents differ little or much from each other namely in the union of individuals of the same variety or of different varieties or of distinct species.

Independently of the question of fertility and sterility in all other respects there seems to be a general and close similarity in the offspring of crossed species and of crossed varieties If we look at species as having been specially created and at varieties as having been produced by secondary laws, this similarity would be an astonishing fact. But it harmonises perfectly with the view that there is no essential distinction between species and varieties.

Summary of Chapter

First crosses between forms, sufficiently distinct to be ranked as species and their hybrids, are very generally but not universally sterile The sterility is of all degrees and is often so slight that the most careful experimentalists have arrived at diametrically opposite conclusions in ranking forms by this test. The sterility is innately variable in individuals of the same species and is eminently susceptible to the action of favourable and unfavourable conditions. The degree of sterility does not strictly follow systematic affinity but is governed by several curious and complex laws. It is generally different and sometimes widely different in reciprocal crosses between the same two species It is not always equal in degree in a first cross and in the hybrids produced from this cross

In the same manner as in grafting trees, the capacity in one species or variety to take on another is incidental on differences, generally of an unknown nature in their vegetative systems, so in crossing the greater or less facility of one species to unite with another is incidental on unknown differences in their

tend to supp..nt the ld and unimpro ed forms.

By the theory of natural selection all li ın species ha been connected with the parent species of each genus, by differences not greater than w see between th natural and domestic .rieties ■ the sam species t the present day and these parent species, now g nerally ext..ct, ha in their turn bee sim larly co nected th more ancient forms and so n backwards, alw con erging to the common ancestor ■ ach great lass. So that th number of intermediat and transitional link be t een al li ing and extinct species, mu t ha been inconcei ably great. B ■ assuredly if this theory be true, such ha li ed pon th earth.

On the Lapse f Time as i ferred from the rate of Deposition and extent of Denu dation

Independently of our not finding fossil re mains of such nfinitely num rous connecting links, t may be objected that time cannot have sufficed for so gre t an amount of organic change al chan es having been ffected slowly It is hardly possible for me to recall to the reader ho is not practical geolog t, the facts leading th mind feebl to comprehend the lapse of tim H ho can read ir Charles Lyell grand work on the *Principle f Geology* which th f t re historian will recognise as having produced a revol tion in natural science and y t does not adm t how ast ha been the past periods of time may at once close this volume Not that t suffices to study th *Principles f Geology* or to read special treatises by different observers o separat formations, and to mark how ach thor t tempts ■ an inadequate idea of the dura tion of each formation, en of each tra tum. W can best gai some idea of past time by knowi g the agencies at work, and learning how deeply the surface of the land has been denuded, and how much sediment has been de posit d. As Ly ll has ll remarked the tent and thickness of our sedime tary formations are the result and the measure ■ the denuda tion hich the arth crust has se here un dergone Therefore man should xamine for himself the great piles of superimposed trata, and atch the ri lets bringi d n mud, and the es w art g th sea-c ffs, in order to comprehend someth ng about the dur ation f pa t t me the monuments of which we ad around us.

It is good t wand along the coast, when formed of mo. rat ly hard rocks, and mark th process of degradation. The tides in mo.t cases reach th cliff only for a sh rt tim twice a da and th wa es eat in.o th m only when th y are charged with sand or pebbles f r there is good dence that pure water ef fects nothin. in wearing w y rock. At last the base of the cliff is undermined, h ge fragm nts fall d wn, and these remainin. fixed ha to be w rn w om b tom, until afte being

of rocky cliff which is und rg in degradation we find that t is onl h re and th re alo . a sh rt l ngth o round promontory that the liff are at th present time suff rin.. Th ppearance f th urface and th egetation show that elsewhere years ha elapsed since th wat rs washed their base.

W have, h w recently learnt from th observations of Ramsay in th van of many excellent observ rs—of J kes, ■ ikie Croll, and oth rs, that subaerial degradation is a much more important a. nc than coast ac tio th power of th wa es. Th wh le sur face of th land is xposed to th ch mical ac tion of th ai and of the rain w t r with ts dissol ed carbonic acid, and n cold r coun tries to frost th disint gr ted matter car ried d wn n gentl lopes dur n. heavy rain, and to a greater xtent than m ht be supposed, especiall in arid districts, by ■ wind t is then transported by th streams and ri ers, which when rapid deepen the chan nels, and trit rat th fragments On a rainy d n in a g tl undulat countr we see the ffects of subaerial d rad tion in th muddy rills which flow d wn ry lope Messrs. Ramsay and Wh take ha shown and the observati n is most triking o e, that th great lines of escarpm nt in th Wealden district and those rangin. across England which f rmerly w re looked at as ncie t se coasts, cannot ha been th f rmed, for each h is composed of ne and th sam f rmation, hilst ou sea-cliff are rywh re f rmed

CHAPTER X

ON THE IMPERFECTION OF THE GEOLOGICAL RECORD

In the sixth chapter I enumerated the chief objections which might be justly urged against the views maintained in this volume. Most of them have now been discussed. One, namely the distinctness of specific forms and their not being blended together by innumerable transitional links, is a very obvious difficulty. I assigned reasons why such links do not commonly occur at the present day under the circumstances apparently most favourable for their presence, namely, on an extensive and continuous area with graduated physical conditions. I endeavoured to show, that the life of each species depends in a more important manner on the presence of other already defined organic forms, than on climate, and, therefore, that the really governing conditions of life do not graduate away quite insensibly like heat or moisture. I endeavoured, also, to show that intermediate varieties, from existing in lesser numbers than the forms which they connect, will generally be beaten out and exterminated during the course of further modification and improvement. The main cause, however, of innumerable intermediate links not now occurring everywhere throughout nature, depends on the very process of natural selection, through which new varieties continually take the places of and supplant their parent forms. But just in proportion as this process of extermination has acted on an enormous scale, so must the number of intermediate varieties, which have formerly existed, be truly enormous. Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain; and this, perhaps, is the most obvious and serious objection which can be urged against the theory. The explanation lies, as I believe, in the extreme imperfection of the geological record.

In the first place, it should always be borne in mind what sort of intermediate forms must, on the theory, have formerly existed. I have found it difficult, when looking at any two species, to avoid picturing to myself forms directly intermediate between them. But this is a wholly false view; we should always look for forms intermediate between each species and a common but unknown progenitor; and the progenitor will generally have differed in some respects from all its modified descendants. To give a simple illustration: the fantail and pouter pigeons are both descended from the rock pigeon; if we possessed all the intermediate varieties which have ever existed, we should

tail and pouter; none, for instance, combining a tail somewhat expanded with a crop somewhat enlarged, the characteristic features of these two breeds. These two breeds, moreover

have determined, from a mere comparison of their structure with that of the rock pigeon, C. livia, whether they had descended from this species or from some allied form, such as C.
nas.

So with natural species, if we look to forms very distinct, for instance to the horse and tapir, we have no reason to suppose that links directly intermediate between them ever existed, but between each and an unknown common parent. The common parent will have had in its whole organisation much general resemblance to the tapir and to the horse; but in some points of structure may have differed considerably from both, even perhaps more than they differ from each other. Hence in all such cases, we should be unable to recognise the parent form of any two or more species, even if we closely compared the structure of the p
ants
perfec

It is just possible by the theory, that one of two living forms might have descended from the other; for instance, a horse from a tapir; and in this case direct intermediate links will have existed between them. But such a case would imply that one form had remained for a very long period unaltered, whilst its descendants had undergone a vast amount of change; and the principle of competition between organism and organism, between child and parent, will render this a very rare event; for in all cases the new and improved forms of life

years. But let it be borne in mind, in relation to the subject of this work, what a hundred years implies, represented as it is by a measure utterly insignificant in a hall of the above dimensions. Several eminent breeders, during a single lifetime, have so largely modified some of the higher animals which propagate their kind much more slowly than most of the lower animals, that they have formed what well deserves to be called a new sub-breed. Few men have attended with due care to any one strain for more than half a century, so that a hundred years represents the work of two breeders in succession. It is not to be supposed that species in a state of nature ever change so quickly as domestic animals under the guidance of methodical selection. The comparison would be in every way fairer with the effects which follow from unconscious selection, that is the preservation of the most *useful or beautiful* animals, with no intention of modifying the breed; but by this process of unconscious selection, various breeds have been sensibly changed in the course of two or three centuries.

Species, however, probably change much more slowly, and within the same country only a *few change at the same time*. This slowness follows from all the inhabitants of the same country being already so well adapted to each other, that new places in the polity of nature do not occur until after long intervals, due to the occurrence of physical changes of some kind, or through the immigration of new forms. Moreover variations or individual differences of the right nature, by which some of the inhabitants might be better fitted to their new places under the altered circumstances, would not always occur at once. Unfortunately we have no means of determining, according to the standard of years, how long a period it takes to modify a species; but to the subject of time we must return.

On the Poorness of Palaeontological Collections

Now let us turn to our richest geological museums, and what a paltry display we behold! That our collections are imperfect is admitted by every one. The remark of that admirable palaeontologist, Edward Forbes, should never be forgotten, namely, that very many fossil species are known and named from single and often broken specimens, or from a few specimens collected on some one spot. Only a small portion of the surface of the earth has been geologically explored, and no part with sufficient care, as the important discoveries made every year in Europe prove. No organism wholly soft can be preserved. Shells and bones decay and disappear when left on the *bottom* of the sea, where sediment is not accumulating. We probably take a quite erroneous view, when we assume that sediment is being *deposited over nearly the whole bed of the sea*, at a rate sufficiently quick to embed and preserve fossil remains. Throughout an enormously large proportion of the ocean, the bright blue tint of the water bespeaks its purity. The many cases on record of a formation conformably covered, after an immense interval of time, by another and later formation, without the underlying bed having suffered in the interval any wear and tear, seem explicable only on the view of the bottom of the sea not rarely lying for ages in an unaltered condition. The remains which do become embedded, if in sand or gravel, will, when the beds are upraised, generally be dissolved by the percolation of rain-water charged with carbonic acid. Some of the many kinds of animals which live on the beach between high and low water mark seem to be rarely preserved. For instance, the several species of the Chthamalinae (a sub-family of sessile cirripedes) coat the rocks all over the world in infinite numbers: they are all strictly littoral, with the exception of a single Mediterranean species, which inhabits deep water, and this has been found fossil in Sicily, whereas not one other species has hitherto been found in any tertiary formation: yet it is known that the genus Chthamalus existed during the Chalk period. Lastly, many great deposits requiring a vast length of time for their accumulation, are entirely destitute of organic remains, without our being able to assign any reason: one of the most striking instances is that of the Flysch formation, which consists of shale and sandstone, several thousand, occasionally even six thousand feet in thickness, and extending for at least 300 miles from Vienna to Switzerland; and although this great mass has been most carefully searched, no fossils, except a few vegetable remains, have been found.

With respect to the terrestrial productions which lived during the Secondary and Palaeozoic periods, it is superfluous to state that our evidence is fragmentary in an extreme degree. For instance, until recently not a land-shell was known belonging to either of these vast periods, with the exception of one species discovered by Sir C. Lyell and Dr. Dawson in the

to the rocks of which they are composed having resisted subaerial denudation better than the surrounding surface this surface consequently has been gradually lowered with the lines of harder rock left projecting Nothing impresses the mind with the vast duration of time according to our ideas of time more forcibly than the conviction th t

u great results

When thus impressed with the slow rate at which the land is worn away through subaerial and littoral action it is good in order to appreciate the past duration of time to consider on the one hand the masses of rock which have been removed over many extensive areas and on the other hand the thickness of our sedimentary formations I remember having been much struck when viewing volcanic islands which have been worn by the waves and pared all round into perpendicular cliffs of one or two thousand feet in height for the gentle slope of the lava streams due to their formerly liquid state showed at a glance how far the hard rocky beds had once extended into the open ocean The same story is told still more plainly by faults —those great cracks along which the strata have been upheaved on one side or thrown down on the other to the height or depth of thousands of feet for since the crust cracked and it makes no great difference whether the upheaval was sudden or as most geologists now believe was slow and effected by many starts the surface of the land

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On the other hand in all parts of the world the piles of sedimentary strata are of wonderful thickness In the Cordillera I estimated one mass of conglomerate at ten thousand feet and although conglomerates have probably been accumulated at a quicker rate than finer sediments yet from being formed of worn and rounded pebbles, each of which bears the stamp of time they are good to show how slowly the mass must have been heaped together Professor Ramsay has given me the maximum thickness, from actual measurement in most cases, of the successive formations in *different* parts of Great Britain and this is the result —

	Feet
Palæozoic strata (not including igneous beds)	5 154
Secondary strata	13,190
Tertiary strata	2, 10

—making altogether 72 584 feet that is, very nearly thirteen and three quarters British miles Some of the formations which are represented in England by thin beds are thousands of feet in thickness on the Continent Moreover between each successive formation we have in the opinion of most geologists, blank periods of enormous length So that the lofty pile of sedimentary rocks in Britain gives but an inadequate idea of the time which has elapsed during their accumulation The consideration of these various facts impresses the mind almost in the same manner as does the vain endeavour to grapple with the idea of eternity

Nevertheless this impression is partly false Mr Croll in an interesting paper remarks that we do not err in forming too great a conception of the length of geological periods, but in estimating them by years. When geologists look at large and complicated phenomena, and then at the figures representing several million years the two produce a totally different effect on the mind and the figures are at once pronounced too small In regard to subaerial denudation Mr Croll shows, by calculating the known amount of sediment annually brought down by certain rivers, relatively to their areas of drainage that 1000 feet of solid rock as it became gradually disintegrated would thus be removed from the mean level of the whole area in the course of six million years This seems an astonishing result and some considerations lead to the suspicion that it may be too large but even if halved or quartered it is still very surprising Few of us, however know what a million really means Mr Croll gives the following illustration take a narrow strip of paper 83 feet 4 inches in length and stretch it along the wall of a large hall then mark off at one end the tenth of an inch This tenth of an inch will represent one hundred years, and the entire strip a million

years. But let it be borne in mind, in relation to the subject of this work, what a hundred years implies, represented as it is by a measure utterly insignificant in a hall of the above dimensions. Several eminent breeders, during a single lifetime, have so largely modified some of the higher animals which propagate their kind much more slowly than most of the lower animals, that they have formed what well deserves to be called a new sub-breed. Few men have attended with due care to any one strain for more than half a century, so that a hundred years represents the work of two breeders in succession. It is not to be supposed that species in a state of nature ever change so quickly as domestic animals under the guidance of methodical selection. The comparison would be in every way fairer with the effects which follow from unconscious selection, that is the preservation of the most useful or beautiful animals, with no intention of modifying the breed; but by this process of unconscious selection, various breeds have been sensibly changed in the course of two or three centuries.

Species, however, probably change much more slowly, and within the same country only a few change at the same time. This slowness follows from all the inhabitants of the same country being already so well adapted to each other, that new places in the polity of nature do not occur until after long intervals, due to the occurrence of physical changes of some kind, or through the immigration of new forms. Moreover variations or individual differences of the right nature, by which some of the inhabitants might be better fitted to their new places under the altered circumstances, would not always occur at once. Unfortunately we have no means of determining, according to the standard of years, how long a period it takes to modify a species; but to the subject of time we must return.

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sucered, b t which will hardly last to distant geological age was deposited d ring down ard oscilation of lev l, and thus gained con- s . . .

. . . sidence b t nl here to sup . . . as suffice t t keep the sea shallow and to embed and preserv the remains before the had time t deca On the oth hand, as long as the bed of the se remains stationary *thick* deposits annot ha been accum lated the shallow parts, which are the most f ourabl to lf . ll fe can thus ha happened durin the alternat periods of le tion t speak more accurat l th bed which w re th n e cumulated w ll generall ha been destro ed by being raised and brought w thi the lim ts of the coast act on.

These remarks apply ch fly t litt ral d sub-littoral deposits. In th case of an ten si and shallow sea, uch as that w thin a lar part of the Malay Archipelago, wh re th depth aries from 30 40 t 60 f th ms, a w ly t ded f rmation might be f rmed during period of l tion, nd t not suffer . . .

. . . ch t was formed as would th d posit be much co sol lated, no be capped b rlying formations, so that t w uld run good hance of bein worn b tinuo ne degrada- t on and b the action of the se luring ubse- quent o lation of le l. It has, how been sugges ed b M H pkins, that f o part of th area aft rising and before be g sea denuded, the deposit formed d the rising mo ement th ugh not thick, might af erward become protected by fresh accum lat ns, and thus be pr rved for long period.

M H pk lso pr sses his belief that sedim tar beds of onsiderable horizontal exte t ha rarel been omp t ly destroyed. B t all eol gists, excepting the f w ho be- lie t at our present metamorphic schists and p tonic roc once f rmed th primordial ucl of th g e d admit that these latt rocks ha been stri t of their co ering to an enormous t nt. For t is scarc ly possible that such rocks could ha e been solidified and crystallized whil t uncovered b t if th m ta- m rphic action occurred t profound depths of th ocean, the forme protecting mantle f rock may n t ha been ery thi k. Admittin th n that gn iss, mica schist granit d orite, . . . necessarily co red up, I w can . . .

. . . cept . . . hee compl t l d nuded of all f ing trata That . . . tens e areas do exist nnot be d lted th granitic region of Parim a d scribed by Humboldt as being as least ni teen t mes as large as S tz land So th of the Amazon, Bo col urs an area composed of rocks of this nature as equal to that f Spain, France, Ital part of German and th Brit ish Islands, ll co j ed. This reg has n t been caref lly explored, b t from th co cu re t testim y of tra llers, the graniti rea is ry large thus, n Eschweg gi es a de- tailed section of these rocks, tret hin from Rio d Janeiro f 60 geogr p cal m les in land in traight lin and I tra lled for 1 0 miles n anothe d rect on, a I saw n thing b t granitic rocks. Num rous pecim ns, col- lect d along th wh le coast from R o de Janeiro t the m th of th Plata, a distance of 1100 geographical miles, were xamined by m and the all belo ed t this las. Inland alo th whole north rn bank of the Plata I saw besides modern t rtiary beds, only one mall patch f slightl m tamorp osed rock, which alo could l f rmed a part of the original capping of the granitic series. Turn ng to w ll kn wn region, namel to th United States and Canada, as shown in Pro sso H D Rogers bea tiful map, I ha estimated the areas b cuttin o t and w ghin th pape and I fi d that the m tamorphic (ex cl ding th sem m tam rphic") and granitic rocks ceed, in th proportion of 19 to 1 t hole of the n wer Palæozo f rmati ns. I many regions th m tam rphic and granitic rocks would be found much m re wid ly t nd d than they ppear to be if all th sedi- m tary beds w re remo ed which rest unco n- f rmabl on them and which could n t ha formed part of th riginal mantle und which th y w re crystallized Hence t is probable that in som parts of th w rld whole f rm tions ha been completely den ded with not wreck left behind.

One remark is here w rth passing notice. During periods f le tion th area of the

carboniferous strata of North America; but now land shells have been found in the lias. In regard to mammiferous remains, a glance at the historical table published in Lyell's *Manual* will bring home the truth, how accidental and rare is their preservation, far better than pages of detail. Nor is their rarity surprising, when we remember how large a proportion of the bones of tertiary mammals have been discovered either in caves or in lacustrine deposits; and that not a cave or true lacustrine bed is known belonging to the age of our secondary or palaeozoic formations.

But the imperfection in the geological record largely results from another and more important cause than any of the foregoing; namely, from the several formations being separated from each other by wide intervals of time. This doctrine has been emphatically admitted by many geologists and palaeontologists, who, like E. Forbes, entirely disbelieve in the change of species. When we see the formations tabulated in written works, or when we follow them in nature, it is difficult to avoid believing that they are closely consecutive. But we know, for instance, from Sir R. Murchison's great work on Russia, what wide gaps there are in that country between the superimposed formations; so it is in North America, and in many other parts of the world. The most skilful geologist, if his attention had been confined exclusively to these large territories, would never have suspected that, during the periods which were blank and barren in his own country, great piles of sediment, charged with new and peculiar forms of life, had elsewhere been accumulated. And if, in each separate territory, hardly any idea can be formed of the length of time which has elapsed between the consecutive formations, we may infer that this could nowhere be ascertained. The frequent and great changes in the mineralogical composition of consecutive formations, generally implying great changes in the geography of the surrounding lands, whence the sediment was derived, accord with the belief of vast intervals of time having elapsed between each formation.

We can, I think, see why the geological formations of each region are almost invariably intermittent; that is, have not followed each other in close sequence. Scarcely any fact struck me more when examining many hundred miles of the South American coasts, which have been upraised several hundred feet within the recent period, than the absence of any recent deposits sufficiently extensive to last for even a short geological period. Along the whole west coast, which is inhabited by a peculiar marine fauna, tertiary beds are so poorly developed, that no record of several successive and peculiar marine faunas will probably be preserved to a distant age. A little reflection will explain why, along the rising coast of the western side of South America, no extensive formations with recent or tertiary remains can anywhere be found, though the supply of sediment must for ages have been great, from the enormous degradation of the coast rocks and from muddy streams entering the sea. The explanation, no doubt, is, that the littoral and sub-littoral deposits are continually worn away, as soon as they are brought up by the slow and gradual rising of the land within the grinding

or extensive masses, in order to withstand the incessant action of the waves, when first upraised and during successive oscillations of level, as well as the subsequent subaerial degradation. Such thick and extensive accumulations of sediment may be formed in two ways; either in profound depths of the sea, in which case the bottom will not be inhabited by so many and such varied forms of life as the more shallow seas; and the mass when upraised will give an imperfect record of the organisms which existed in the neighbourhood during the period of its accumulation. Or sediment may be deposited to any thickness and extent over a shallow bottom, if it continue slowly to subside. In this latter case, as long as the rate of subsidence and the supply of sediment nearly balance each other, the sea will remain shallow and favourable for many and varied forms, and thus a rich fossiliferous formation, thick enough, when upraised, to resist a large amount of denudation, may be formed.

I am convinced that nearly all our ancient

watched the progress of geology, and have been surprised to note how author after author, in treating of this or that great formation, has come to the conclusion that it was accumulated during subsidence. I may add, that the only ancient tertiary formation on the west coast of South America, which has been bulky enough to resist such degradation as it has yet

of th glacial period, instead of h ing been really far greater that is, tend g from before the glacial epoch I th present day

In ord to g t perfect grad ti n between two forms in the uppe and low parts of th same form tion, the d po t must ha g n on co tin ously accum lating d rin long period fficient f th sl w process f mod

approximat ly the same which necessary that the sam mari pecies may li n th same space, the supply of sedim t must nearly count rbalance th am unt f subsidence. B t this same m ment of subsid nce ill tend to bm rg th area wh ce the sediment is deri ed and th diminish the ppl whil t th d ward m m nt co tin es. I fact, this arl xact balancing bet een the ppl f sedim t and the am unt of bsidence is probably rare co t g ncy for t has been observed by m re than ne palæontologist, that ry thick d posits are usually barre of rganic remains, except n ar their ppe low lim ts.

It ould seem that ach separat f rmation, lik the hole p le of f rm t ns in any country has gen ally bee int rm ttent in ts accum lation. When w see as is so oft th ase f rmation composed of bed of wid ly diff re t m ak gical composition, w may reasonabl u pect that th process of d position has been more les terrupted. N ill the closest pection of f rmatio gi e us an id of th le gth of tim which ts d position may ha cons med Man stances could be gi of beds only few feet in thickness, represe t f rmati s, which are lsewhere th ousan l of feet thickness, and hich must ha required an normo period for thei accumulation t no norant of th is fact would ha en u pected the ast lapse of t m represe t d b th thinner formation. Man cases could be gi of the lower b d of format on ha n been upraised, denuded and merged, and th en re-covered b the ppe b d of the same formation, —facts, sh hat t asily looked ter als ha occurred ts accum lat n I othe ases w ha the plainest idence in gre t fossilised trees, til standin

upright as th y grew of ma y l g int rvals of time and chang f l l during the process of deposition, which w ld n t ha been suspected had t th trees been preserved thus S C Ly ll and Dr D wson found carboni f rous beds 1400 feet thick in No a Scot a, w th ancient root-bearin strata, on abo e ll tl r t less than ixty-ei ht diff rent l

sam spot d rin th e wh le period f depos t n, b t has disappeared and reappeared per hap many times, durin the sam geol gical period Consequ tly if it were to undergo a consid rabl am unt f modification during th d positi n of any ne geol gical f rmat on a sectio would n t includ all th fin int rmediate gradat ns which must on ur theory ha xisted, b t abrupt, th gh perh p

f re ce between any two f ms, th y rank both as peci s, unless th y are nabled to connect th m t tl by th closest int rmediate grad t ns and this, from the reasons y t assigned, w can seld m h pe t ffect in any

tri tly int rmed t between B and C t w ld simply be ranked as third and distin t speci s, nl ss t tl sam tim t could be cl sely connected by int mediate a t es w th th both f rms. N ho ld t be f gotten, as bef re explained th t A might be tl act al prog t of B and C and t w ld not ecessarily be tri tly int rmediat between th m in all respects. So th t w m ght obtai tl parent species, and t se ral modified d scendants from th l w and ppe beds of th sam f rmation, and less w obtained m rous transit al gradations, w sh ld not recognise th ir blood relationsh p and should conseq tly rank th m as distin t spec es.

It is notorious on what xcess ly l ht dif f rences many palæo t log ts ha e f unded their pecie and th d this th m re read ly if th pecim ns om from diff rent ub tages of the sam formation. Som xperi nced concholog t are w sinking many f

land and of the adjoining shoal parts of the sea will be increased, and new stations will often be formed;—all circumstances favourable, as previously explained, for the formation of new varieties and species; but during such periods there will generally be a blank in the geological record. On the other hand, during subsidence, the inhabited area and number of inhabitants will decrease (excepting on the shores of a continent when first broken up into an archipelago), and consequently during subsidence, though there will be much extinction, few new varieties or species will be formed; and it is during these very periods of subsidence, that the deposits which are richest in fossils have been accumulated.

On the Absence of Numerous Intermediate Varieties in any Single Formation

From these several considerations, it cannot be doubted that the geological record, viewed as a whole, is extremely imperfect; but if we confine our attention to any one formation, it becomes much more difficult to understand why we do not therein find closely graduated varieties between the allied species which lived at its commencement and at its close. Several cases are on record of the same species presenting varieties in the upper and lower parts of the same formation; thus, Trautschold gives a number of instances with ammonites; and Hilgendorf has described a most curious case of ten graduated forms of *Planorbis multiformis* in the successive beds of a fresh-water formation in Switzerland. Although each formation has indisputably required a vast number of years for its deposition, several reasons can be given why each should not commonly include a graduated series of links between the species which lived at its commencement and close; but I cannot assign due proportional weight to the following considerations.

Although each formation may mark a very long lapse of years, each probably is short compared with the period requisite to change one species into another. I am aware that two palæontologists, whose opinions are worthy of much deference, namely Bronn and Woodward, have concluded that the average duration of each formation is twice or thrice as long as the average duration of specific forms. But insuperable difficulties, as it seems to me, prevent us from coming to any just conclusion on this head. When we see a species first appearing in the middle of any formation, it would be rash in the extreme to infer that it had not elsewhere previously existed. So again when we find a species disappearing before the last layers have been deposited, it would be equally rash to suppose that it then became extinct. We forget how small the area of Europe is compared with the rest of the world; nor have the several stages of the same formation throughout Europe been correlated with perfect accuracy.

We may safely infer that with marine animals of all kinds there has been a large amount of migration due to climatal and other changes; and when we see a species first appearing in any formation, the probability is that it only then first immigrated into that area. It is well known, for instance, that several species appear somewhat earlier in the palæozoic beds of North America than in those of Europe; time having apparently been required for their migration from the American to the European seas. In examining the latest deposits in various quarters of the world, it has everywhere been noted, that some few still existing species are common in the deposit, but have become extinct in the immediately surrounding sea; or, conversely, that some are now abundant in the neighbouring sea, but are rare or absent in this particular deposit. It is an excellent lesson to reflect on the ascertained amount of migration of the inhabitants of Europe during the

of climate, and on the great lapse of time, all included within this same glacial period. Yet it may be doubted whether, in any quarter of the world, sedimentary deposits, *including fossil remains*, have gone on accumulating within the same area during the whole of this period. It is not, for instance, probable that sediment was deposited during the whole of the glacial period near the mouth of the Mississippi, within that limit of depth at which marine animals can best flourish: for we know that great geographical changes occurred in other parts of America during this space of time. When such beds as were deposited in shallow water near the mouth of the Mississippi during some part of the glacial period shall have been upraised, organic remains will probably first appear and disappear at different levels, owing to the migrations of species and to geographical changes. And in the distant future, a geologist, examining these beds, would be tempted to conclude that the average duration of life of the embedded fossils had been less than that

tion of the geological record under an imaginary illustration. The Malay Archipelago is about the size of Europe from the North Cape to the Mediterranean, and from Britain to Russia; and therefore equals all the geological formations which have been examined with any accuracy, excepting those of the United States of America. I fully agree with Mr. Godwin-Austen, that the present condition of the Malay Archipelago, with its numerous large islands separated by wide and shallow seas, probably represents the former state of Europe, whilst most of our formations were accumulating. The Malay Archipelago is one of the richest regions in organic beings; yet if all the species were to be collected which have ever lived there, how imperfectly would they represent the natural history of the world!

But we have every reason to believe that the terrestrial productions of the archipelago would be preserved in an extremely imperfect manner in the formations which we suppose to be there accumulating. Not many of the

any one great period of subsidence over the whole or part of the archipelago, together with a contemporaneous accumulation of sediment, would exceed the average duration of the same specific forms; and these contingencies are indispensable for the preservation of all the transitional gradations between any two or more species. If such gradations were not all fully preserved, transitional varieties would merely appear as so many new, though closely allied species. It is also probable that each great period of subsidence would be interrupted by oscillations of level, and that slight climatal changes would intervene during such lengthy periods; and in these cases the inhabitants of the archipelago would migrate, and no closely consecutive record of their modifications could be preserved in any one formation.

to the belief that it would be chiefly these far-ranging species, though only some of them, which would often produce new varieties; and the varieties would at first be local or co

sediment did not accumulate on the bed of the sea, or where it did not accumulate at a sufficient rate to protect organic bodies from decay, no remains could be preserved.

Formations rich in fossils of many kinds, and of thickness sufficient to last to an age as distant in futurity as the secondary formations lie in the past, would generally be formed in the archipelago only during periods of subsidence. These periods of subsidence would be separated from each other by immense intervals of time, during which the area would be either stationary or rising; whilst rising, the fossiliferous formations on the steeper shores would be destroyed, almost as soon as accumulated, by the incessant coast-action, as we now see on the shores of South America. Even throughout the extensive and shallow seas within the archipelago, sedimentary beds could hardly be accumulated of great thickness during the periods of elevation, or become capped and protected by subsequent deposits, so as to have a good chance of enduring to a very distant future. During the periods of subsidence, there would probably be much extinction of life; during the periods of elevation, there would be much variation, but the geological record would then be less perfect.

It may be doubted whether the duration of

differ from their former state in a nearly uniform, though perhaps extremely slight degree, and as they would be found embedded in slightly different sub-stages of the same formation, they would, according to the principles followed by many palaeontologists, be ranked as new and distinct species.

If then there be some degree of truth in these remarks, we have no right to expect to find, in our geological formations, an infinite number of those fine transitional forms which, on our theory, have connected all the past and present species of the same group into one long and branching chain of life. We ought only to look for a few links, and such assuredly we do find—some more distantly, some more closely, related to each other; and these links, let them be ever so close, if found in different stages of the same formation, would, by many palaeontologists, be ranked as distinct species. But I do not pretend that I should ever have suspected how poor was the record in the best preserved geological sections, had not the absence of innumerable transitional links between the species which lived at the com

the very fine species of D'Orbigny and others into the rank of varieties and on this view we do find the kind of evidence of change which on the theory we ought to find Look again at the later tertiary deposits which include many shells believed by the majority of naturalists to be identical with existing species but some excellent naturalists as Agassiz and Pictet maintain that all the tertiary species are specifically distinct though the distinction is admitted to be very slight so that here unless we believe that these eminent naturalists have been misled by their imaginations and that these late tertiary species really present no difference whatever from their living representatives or unless we admit in opposition to the judgment of most naturalists that these tertiary species are all truly distinct from the recent we have evidence of the frequent occurrence of slight modifications of the kind required It we look to rather wider intervals of time namely to distinct but consecutive stages of the same great formation we find that the embedded fossils though universally ranked as specifically different yet are far more closely related to each other than are the species found in more widely separated formations so that here again we have undoubted evidence of change in the direction required by the theory but to this latter subject I shall return in the following chapter

With animals and plants that propagate rapidly and do not wander much there is reason to suspect as we have formerly seen that their varieties are generally at first local and that such local varieties do not spread widely and supplant their parent forms until they have been modified and perfected in some considerable degree According to this view the chance of discovering in a formation in any one country all the early stages of transition between any two forms is small for the successive changes are supposed to have been local or confined to some one spot Most marine animals have a wide range and we have seen that with plants it is those which have the widest range that oftenest present varieties so that, with shells and other marine animals, it is probable that those which had the widest range far exceeding the limits of the known geological formations in Europe have oftenest given rise first to local varieties and ultimately to new species and this again would greatly lessen the chance of our being able to trace the stages of transition in any one geological formation

It is a more important consideration leading to the same result as lately insisted on by Dr Falconer namely that the period during which each species underwent modification though long as measured by years was probably short in comparison with that during which it remained without undergoing any change

It should not be forgotten that at the present day with perfect specimens for examination two forms can seldom be connected by intermediate varieties and thus proved to be the same species until many specimens are collected from many places and with fossil species this can rarely be done We shall perhaps best perceive the improbability of our being enabled to connect species by numerous fine intermediate fossil links by asking ourselves whether for instance geologists at some future period will be able to prove that our different breeds of cattle sheep horses and dogs are descended from a single stock or from sev

gists as distinct species from their European representatives and by other conchologists as only varieties are really varieties or are as it is called specifically distinct This could be effected by the future geologist only by his discovering in a fossil state numerous intermediate gradations and such success is improbable in the highest degree

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It may be worth while to sum up the foregoing remarks on the causes of the imperfec

tio of the geol g cal ecord nd r n m g ... nary ll trati Th Malay A l p l g is al t the ize of E rope fr m th N rth C p to tl e M d t rra ea and from Brita n to R ss and th r f re equ ls all tl geol gi al f m t ns h ch h bee m d with any accu acy e c pt g th s f tl U t d S t f Am r a. I f lly g e tl Mr God

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represe t th n tural h tory f tl wo ld[1]

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w ld b d t yed alm t as soo as accumu lat d by th ssant coast act as w w see th sh re f So th Am ca. E en thro gh t tl e tens e and hall w seas th tl arch pel g sed m tary bed co ld hardly be accum l ted f great th ck ss d ing tl period f l t on bec m e pp d and p tected l y bseq t d po ts, so as to ha good l ce f duri g to y d s tant f g the p ods f b sidence, th m ld prob bly be m ch exti ct f lif d ing tl p od f l t n th ld b m l ar tio b t th geological ecord ll tl be less perfect.

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With animals and plants that propagate rapidly and do not wander much, there is reason to suspect, as we have formerly seen, that their varieties are generally at first local; and that such local varieties do not spread widely and supplant their parent forms until they have been modified and perfected in some considerable degree. According to this view, the chance of discovering in a formation in any one country all the early stages of transition between any two forms is small, for the successive changes are supposed to have been local or confined to some one spot. Most marine animals have a wide range; and we have seen that with plants it is those which have the widest range, that oftenest present varieties; so that, with shells and other marine animals, it is probable that those which had the widest range, far exceeding the limits of the known geological formations in Europe, have oftenest given rise, first to local varieties and ultimately to new species; and this again would greatly lessen the chance of our being able to trace the stages of transition in any one geological formation.

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It should not be forgotten, that at the present day, with perfect specimens for examination, two forms can seldom be connected by intermediate varieties and thus proved to be the same species, until many specimens are collected from many places; and with fossil species this can rarely be done. We shall perhaps best perceive the improbability of our being enabled to connect species by numerous, fine, intermediate, fossil links, by asking ourselves whether, for instance, geologists at some future period will be able to prove that our different breeds of cattle, sheep, horses, and dogs are descended from a single stock or from several

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It may be worth while to sum up the foregoing remarks on the causes of the imperfection

family lived during the deposition of the upper greensand; and still more recently, that strange bird, the Archeopteryx, with a long lizard-like tail, bearing a pair of feathers on each joint, and with its wings furnished with two free claws, has been discovered in the oolitic slates of Solenhofen. Hardly any recent discovery shows more forcibly than this, how little we as yet know of the former inhabitants of the world.

I may give another instance, which, from having passed under my own eyes, has much struck me. In a memoir on *Fossil Sessile Cirripedes*, I stated that, from the large number of existing and extinct tertiary species; from the extraordinary abundance of the individuals of many species all over the world, from the Arctic regions to the equator, inhabiting various zones of depths from the upper tidal limits to 50 fathoms; from the perfect manner in which specimens are preserved in the oldest tertiary beds; from the ease with which even a fragment of a valve can be recognised; from all these circumstances, I inferred that, had sessile cirripedes existed during the secondary periods, they would certainly have been preserved and discovered; and as not one species had then been discovered in beds of this age, I concluded that this great group had been suddenly developed at the commencement of the tertiary series. This was a sore trouble to me, adding as I then thought one more instance of the abrupt appearance of a great group of species. But my work had hardly been published, when a skilful palaeontologist, M. Bosquet, sent me a drawing of a perfect specimen of an unmistakable sessile cirripede, which he had himself extracted from the chalk of Belgium. And, as if to make the case as striking as possible, this cirripede was a Chthamalus, a very common, large, and ubiquitous genus, of which not one species has as yet been found even in any tertiary stratum. Still more recently, a Pyrgoma, a member of a distinct subfamily of sessile cirripedes, has been discovered by Mr. Woodward in the upper chalk; so that we now have abundant evidence of the existence of this group of animals during the secondary period.

The case most frequently insisted on by palaeontologists of the apparently sudden appearance of a whole group of species, is that of the teleostean fishes, low down, according to Agassiz, in the Chalk period. This group includes the large majority of existing species. But certain Jurassic and Triassic forms are now commonly admitted to be teleostean; and even some palaeozoic forms have thus been classed by one high authority. If the teleosteans had really appeared suddenly in the northern hemisphere at the commencement of the chalk formation the fact would have been highly remarkable; but it would not have formed an insuperable difficulty, unless it could likewise have been shown that at the same period the species were suddenly and simultaneously developed in other quarters of the world. It is almost superfluous to remark that hardly any fossil-fish are known from south of the equator; and by running through Pictet's *Palaeontology* it will be seen that very few species are known from several formations in Europe. Some few families of fish now have a confined range; the teleostean fishes might formerly have had a similarly confined range, and after having been largely developed in some one sea, have spread widely. Nor have we any right to suppose that the seas of the world have always been so freely open from south to north as they are at present. Even at this day, if the Malay Archipelago were converted into land, the tropical parts of the Indian Ocean would form a large and perfectly enclosed basin, in which any great group of marine animals might be multiplied; and here they would remain confined, until some of the species became adapted to a cooler climate, and were enabled to double the Southern capes of Africa or Australia, and thus reach other and distant seas.

From these considerations, from our ignorance of the geology of other countries beyond the confines of Europe and the United States, and from the revolution in our palaeontological knowledge effected by the discoveries of the last dozen years, it seems to me to be about as rash to dogmatize on the succession of organic forms throughout the world, as it would be for a naturalist to land for five minutes on a barren point in Australia, and then to discuss the number and range of its productions.

On the sudden Appearance of Groups of allied Species in the lowest known Fossiliferous Strata

There is another and allied difficulty, which is much more serious. I allude to the manner in which species belonging to several of the main divisions of the animal kingdom suddenly appear in the lowest known fossiliferous rocks. Most of the arguments which have convinced me that all the existing species of the same group are descended from a single progenitor

mencement and close of each formation pressed so hardly on my theory

On the sudden Appearance of whole Groups of allied Species

The abrupt manner in which whole groups of species suddenly appear in certain formations has been urged by several palæontologists—for instance by Agassiz Pictet and Sedgwick—as a fatal objection to the belief in the transmutation of species If numerous species belonging to the same genera or families have really started into life at once the fact would be fatal to the theory of evolution through natural selection To th

... timate the perfection of the geological record and falsely infer because certain genera or families have not been found beneath a certain stage that they did not exist before that stage In all cases positive palæontological evidence may be implicitly trusted negative evidence is worthless as experience has so often shown We continually forget how large the world is compared with the area over which our geological formations have been carefully examined we forget that groups of species may elsewhere have long existed and have slowly multiplied before they invaded the ancient archipelagoes of Europe and the United States We do not make due allowance for the intervals of time which have elapsed between our consecutive formations —longer perhaps in many cases than the time required for the accumulation of each formation These intervals will have given time for the multiplication of species from some one parent form and in the succeeding formation such groups or species will appear as if suddenly created

I may here recall a remark formerly made namely that it might require a long succe... n

forms would often long remain confined to some one region but that when this adaptation had once been effected and a few species

throughout the world Professor Pictet, in his excellent review of this work in commentin on early transitional forms, and taking birds as an illustration cannot see how the successive modifications of the anterior limbs of ...

... of many kinds I do not s...

... up along the surface of the sea like the logger headed duck and ultimately to rise from its surface and glide through the air?

I will now give a few examples to illustrate the foregoing remarks and to show how liable we are to error in supposing that whole groups of species have suddenly been produced Even in so short an interval as that between the first and second editions of Pictet s great work on *Palæontology* published in 1844–46 and in 1853–57 the conclusions on the first appearance and disappearance of several groups of animals have been considerably modified and a third edition would require still further changes I may recall the well known fact that in geological treatises, published not many years ago mammals were always spoken of as having abruptly come in at the commencement of the tertiary series And now one of the richest known accumulations of fossil mammals belongs to the middle of the secondary series and true mammals have been discovered in the new red sandstone at nearly the commencement of this great series Cuvier used to urge that no monkey occurred in any tertiary stratum but now extinct species have been discovered in India, ... back as ... the rare ... footsteps in the new red sandstone of the United States, who would have ventured to suppose that no less than at least thirty different bird like animals some of gigantic size existed during that period Not a fragment of bone has been discovered in these beds Not long ago palæontologists maintained that the whole class of birds came suddenly into existence during the ... period but now we know on the authority of Professor Owen that a bird cer...

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There is another and allied difficulty, which is much more serious. I allude to the manner in which species belonging to several of the main divisions of the animal kingdom suddenly appear in the lowest known fossiliferous rocks. Most of the arguments which have convinced me that all the existing species of the same group are descended from a single progenito

apply with equal force to the earliest known species For instance it cannot be doubted that all the Cambrian and Silurian trilobites are descended from some one crustacean which must have lived long before the Cambrian age and which probably differed greatly from any known animal Some of the most ancient animals as the Nautilus, Lingula &c do not differ much from living pecies and it cannot on our theory be supposed that these old species were the progenitors of all the species belonging to the same groups which have subsequently appeared fo they are not

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whether the earth in a fit tate for the habitation of living creature has lasted long enough Sir W Thompson concludes that the consolidation of the crust can hardly have occurred le s than 20 or more than 400 million years ago but probably not less than 98 or more than 200 million years These very wide limits show how doubtful the data are and other elements may have hereafter to be introduced into the problem Mr Croll e timates that about 60 million years have elapsed since the Cambrian period but this judging from the small amount of organic change since the commencement of the Glacial epoch appears a very short time for the many and great mutations of life which have certainly occurred since the Cambrian formation and the previous 140 million years can hardly be considered as sufficient for the development of the varied forms of life which already existed during the Cambrian period It is, however prob able as Sir William Thompson insists that the world at a very early period as

would have tended to induce changes at a corre ponding rate in the organisms which then existed

To the question why we do not find rich fossiliferous deposits belonging to these assumed earliest periods prior to the Cambrian system I can give no satisfactory answer Several eminent geologists, with Sir R Murchison at their head were until recently convinced that we beheld in the organic remains of the lowest Silurian stratum the first dawn of life Other highly competent judges, as Lyell and E Forbes have di puted this conclusion We should not forget that only a small portion of the world is known with accuracy Not very long ago M Barrande ad led another and lo er stage abounding with new and peculiar species beneath the then known Silurian syst m and now still lower down in the Lower Cambrian formation Mr Hicks has found in South Wales beds rich in trilobites, and containing various molluscs and annelids The presence of pho phatic nodules and bituminous matter even in some of the lowest azoic rocks, probably indicates life at these periods and the existence of the Eozoon in the Laurentian formation of Canada is generally a lmitted There are three great serie of

s rpass that of all the succeeding rocks, from the base of the palæozoic series to the present time We are thus carried back to a period so remote that the appearance of the so-called primordial fauna (of Barrande) may by some be considered as a comparatively modern event The Eozoon belongs to the most lowly organised of all classes of animal but is highly organised for its class it existed in countless numbers and

ons, which I wrote in 18 9 about the exi tence of living beings long before the Cambrian period and which are almo t the same with those since used by Sir W Logan have proved true Nevertheless, the difficulty of assigning any good reason for the absence of vast piles of strata rich in fossils beneath the Cambrian system is very great. It does not seem probable that the m t ancient b ds ha e been quite worn away by denudation or that their fossils have been wholly obliterated by metamorphic action for if this had been the case we could have found only mall remnants of th format ons next succeeding them in age and these would always have exi ted in partially metamorphosed con ition But the descr ptions which we po sess of the Silurian deposits over immense territo s in Russia ar l in North Amer ca do not support the view that the older a formation is, the more invariably it has uff red extreme denudation and m tam rph m.

Th case at present mu t remain inexplic abl and may be truly urged as a val l argu m t again t the v e h re t rtai ed To show that t may h reafter eece e some ex planati n, I ill gi th f ll win hypothesis. From tl t re f th org e remains wh ch d not pear to h inhab ted profo d depths, in th seve al f rmati ns f E rope and f th United States and from tl m t of sedim t, mil in th ckn ss, f which th f rmations are composed w m y nf r that from first to la t larg lands tracts f land, h ce tl sed m t was d ri ed occ rred in th glibo hood f th w xisting co t ents f Europe and N rth Am rica. This sam w Las nce been maintained by Agas sız and th rs. B t d t kn w hat was th tate f things in th int rv ls betwee th sev ral successn form t n. wh tl r E rope and th United State durın th se int als isted as dry land, as bmarın rf ce ar land which sed m t was n t de po ted, as th bed f an pen and unf th omal le sea.

Looki g t th isting oceans, whi h are thrice as t ns as th land w see th m t dded w th man land b t hardly trul oceanic island (th th cepti n f New Zealand, if this can be called truly oceani land) as y t kn wn t aff rd n remnant f any palæo ic secondary f matio H nce m pe h p inf that during th palæozo and seco dar periods, th co tin ts co tin tal land isted wh re oceans w t nd f had they existed palæozo and seco dary f rma tions ould all probability h been ac cum lated from sed m t d ri ed from th ir ar and t ar and tl se w uld h been t least partially ph ed b th oscillati ns f le l, wl ich m t ha int rv ed during these rm usly long periods. If th w m y inf an thing from th se facts, we m y inf that h re oceans n w t d oceans ha t ded from tl rem test period of wl h w h any record and th th ha l that wh re co ti ts now t, larg tracts of land ha ted bjected d bt to great oscillations f l l, ince th Cam b ian period Th colo red m p ppended to m l m oral reefs, led m t co cl d that the great oceans are till mainl areas of l sul nce the gre t rch pela oe till reas w llat ns f l l, and th co tinents areas of le tion. B t w h reason to assum that th g l tl remai ed from

the beginn ng of tle w rld O contu s seem to h v been formed b a prepo derance d in many oscillat ons of l el, f the f rce f ti n b t m y t th areas of pre po d rant m m nt h cl an ed in th lapse f At a period l anteced t to th Cambrian poch co tin ts may h existed wl re oceans are now pread ut and lear and pen ocea s m y h e ex ted where co t ts now tand N r sho ld we be ju tified n assumin that f f tance the bed of th Pacifi Ocean w re no con erted t co t n t w h ld th re find sed

m ght w ll happen tl t trata h ch had b- sided som m l s n arc to the centre f the arth and which had been p essed on by an rm w ght f perm mbent w t r m gl t ha und r e f m re met morph c act n than trata which h alw ys re mained ar r to th surf ce The me se areas in som parts f th w ld f r tance in South Am rica, of naked m tam rph c rocks, wl ch m t l been h ted under gre t press re, h v lw v seemed to me t req re some special plan t n d w may pe h p beh that see in these large ar as, tl m y f rmat ns l g anteri r to the C mbrian poch n a compl t ly m ta m rpl sed and d ded co d t n.

Th se rald ffic lt e h redisc ssed nam ly —th t, tl gh we find n geol gi al f m ti ns many links betwee tl spec wh h n w xist and which f rm l xi ted w d not find infinit ly num rou fin tran tional f rms closely j ini g th m all tog th —th dd n mann in which se r l gro p of speci first ppear in Europe n form tions —th almost ent re bsence as t present kn wn f f rm tions rich in f s ils be ath th Cambrian trata,—are ll u l btedly of th most serio nature W see thi th fact th t th most m nt palæo t lo ists, n m ly Cu er Agassiz, Barrand l t t Falco E. F rbes, &c., and all r gre test geol gists, as Ly ll Murchiso Sedgw k, &c.

geological record is in any d gree perfect, will d ubtedly t ce reject th theory F my

part following out Lyell's metaphor I look at the geological record as a history of the world imperfectly kept and written in a changing dialect of this history we possess the last volume alone relating only to two or three countries. Of this volume only here and there a short chapter has been preserved and of each page only here and there a few lines Each word of the slowly-changing language more or less different in the successive chapters, may represent the forms of life which are entombed in our consecutive formations, and which falsely appear to have been abruptly introduced On this view the difficulties above discussed are greatly diminished or even disappear

CHAPTER XI

ON THE GEOLOGICAL SUCCESSION OF ORGANIC BEINGS

Let us now see whether the several facts and laws relating to the geological succession of organic beings accord best with the common view of the immutability of species, or with that of their slow and gradual modification, through variation and natural selection.

New species have appeared very slowly, one after another, both on the land and in the waters. Lyell has shown that it is hardly pos-

tages, and to make the proportion between the lost and existing forms more gradual. In

only one or two new ones having appeared for the first time, either locally, or, as far as we know, on the face of the earth. The secondary formations are more broken; but, as Bronn has remarked, neither the appearance nor disappearance of the many species embedded in each formation has been simultaneous.

Species belonging to different genera and classes have not changed at the same rate, or in the same degree. In the older tertiary beds a few living shells may still be found in the midst of a multitude of extinct forms. Falconer has given a striking instance of a similar fact, for an existing crocodile is associated with many lost mammals and reptiles in the sub-Himalayan deposits. The Silurian Lingula differs but little from the living species of this genus; whereas most of the other Silurian molluscs and all the crustaceans have changed greatly. The productions of the land seem to have changed at a quicker rate than those of the sea, of which a striking instance has been observed in Switzerland. There is some reason to believe that organisms high in the scale, change more quickly than those that are low: though there are exceptions to this rule. The amount of organic change, as Pictet has remarked, is not the same in each successive so-called formation. Yet if we compare any but the most closely related formations, all the species will be found to have undergone some change. When a species has once disappeared from the face of the earth, we have no reason to believ

Barrande, which intrude for a period in the midst of an older formation, and then allow the pre-existing fauna to reappear; but Lyell's explanation, namely, that it is a case of temporary migration from a distinct geographical province, seems satisfactory.

These several facts accord well with our theory, which includes no fixed law of development, causing all the inhabitants of an area to change abruptly, or simultaneously, or to an equal degree. The process of modification must be slow, and will generally affect only a few species at the same time; for the variability of each species is independent of that of all others. Whether such variations or individual differences as may arise will be accumulated through natural selection in a greater or less degree, thus causing a greater or less amount of permanent modification, will depend on many complex contingencies—on the variations being of a beneficial nature, on the freedom of intercrossing, on the slowly changing physical conditions of the country, on the immigration of new colonists, and on the nature of the other inhabitants with which the varying species come into competition. Hence it is by no means surprising that one species should retain the same identical form much longer than others; or, if changing, should change in a less degree. We find similar relations between the existing inhabitants of distinct countries; for instance, the land-shells and coleopterous insects of Madeira have come to differ considerably from their nearest allies on the continent of Europe, whereas the marine shells and birds have remained unaltered. We can perhaps understand the apparently quicker rate of change in terrestrial and in more highly organised productions compared with marine and lower

area have become modified and improved, we can understand, on the principle of competition, and from the all-important relations of organism to organism in the struggle for life,

that any form which did not become in some degree modified and improved would be liable to extermination. Hence we see why all the species in the same region do at last, if we look to long enough intervals of time, become modified, for otherwise they would become extinct.

In members of the same class the average amount of change, during long and equal periods of time, may perhaps be nearly the same; but as the accumulation of enduring formations, rich in fossils, depends on great masses of sediment being deposited on subsiding areas, our formations have been almost necessarily accumulated at wide and irregularly intermittent intervals of time; consequently the amount of organic change exhibited by the fossils embedded in consecutive formations is not equal. Each formation, on this view, does not mark a new and complete act of creation, but only an occasional scene, taken almost at hazard, in an ever slowly changing drama.

We can clearly understand why a species when once lost should never reappear, even if the very same conditions of life, organic and inorganic, should recur. For though the offspring of one species might be adapted (and no doubt this has occurred in innumerable instances) to fill the place of another species in the economy of nature, and thus supplant it; yet the two forms—the old and the new—would not be identically the same; for both would almost certainly inherit different characters from their distinct progenitors; and organisms already differing would vary in a different manner. For instance, it is possible, if all our fantail pigeons were destroyed, that fanciers might make a new breed hardly distinguishable from the present breed; but if the parent rock pigeon were likewise destroyed, and under nature we have every reason to believe that parent forms are generally supplanted and exterminated by their improved offspring, it is incredible that a fantail, identical with the existing breed, could be raised from any other species of pigeon, or even from any other well established race of the domestic pigeon, for the successive variations would almost certainly be in some degree different, and the newly formed variety would probably inherit from its progenitor some characteristic differences.

Groups of species, that is, genera and families, follow the same general rules in their appearance and disappearance as do single species, changing more or less quickly, and in a greater or lesser degree. A group, when it has once disappeared, never reappears; that is, its existence, as long as it lasts, is continuous. I am aware that there are some apparent exceptions to this rule, but the exceptions are surprisingly few, so few that E. Forbes, Pictet, and Woodward (though all strongly opposed to such views as I maintain) admit its truth; and the rule strictly accords with the theory. For all the species of the same group, however long it may have lasted, are the modified descendants one from the other, and all from a common progenitor. In the genus *Lingula*, for instance, the species which have successively appeared at all ages must have been connected by an unbroken series of generations, from the lowest Silurian stratum to the present day.

We have seen in the last chapter that whole groups of species sometimes falsely appear to have been abruptly developed; and I have attempted to give an explanation of this fact, which if true would be fatal to my views. But such cases are certainly exceptional; the general rule being a gradual increase in number, until the group reaches its maximum, and then, sooner or later, a gradual decrease. If the number of the species included within a genus, or the number of the genera within a family, be represented by a vertical line of varying thickness, ascending through the successive geological formations, in which the species are found, the line will sometimes falsely appear to begin at its lower end, not in a sharp point, but abruptly; it then gradually thickens upwards, often keeping of equal thickness for a space, and ultimately thins out in the upper beds, marking the decrease and final extinction of the species. This gradual increase in number of the species of a group is strictly conformable with the theory, for the species of the same genus, and the genera of the same family, can increase only slowly and progressively; the process of modification and the production of a number of allied forms necessarily being a slow and gradual process,—one species first giving rise to two or three varieties, these being slowly converted into species, which in their turn produce by equally slow steps other varieties and species, and so on, like the branching of a great tree from a single stem, till the group becomes large.

On Extinction

We have as yet only spoken incidentally of the disappearance of species and of groups of species. On the theory of natural selection, the extinction of old forms and the production of

new and improved forms are intimately connected together. The old notion of all the inhabitants of the earth having been swept away by catastrophes at successive periods is very generally given up, even by those geologists, as Elie de Beaumont, Murchison, Barrande, &c., whose general views would naturally lead them to this conclusion. On the contrary, we have every reason to believe, from the study of the tertiary formations, that species and groups of species gradually disappear, one after another, first from one spot, then from another, and finally from the world. In some few cases, however, as by the breaking of an isthmus and the consequent irruption of a multitude of new inhabitants into an adjoining sea, or by the final subsidence of an island, the process of extinction may have been rapid. Both single species and whole groups of species last for very unequal periods; some groups, as we have seen, have endured from the earliest known dawn of life to the present day; some have disappeared before the close of the palæozoic period. No fixed law seems to determine the length of time during which any single species or any single genus endures. There is reason to believe that the extinction of a whole group of species is generally a slower process than their production: if their appearance and disappearance be represented, as before, by a vertical line of varying thickness the line is found to taper *more gradually at its upper end*, which marks the progress of extermination, than at its lower end, which marks the first appearance and the early increase in number of the species. In some cases, however, the extermination of whole groups, as of ammonites, towards the close of the secondary period, has been wonderfully sudden.

The extinction of species has been involved in the most gratuitous mystery. Some authors have even supposed that, as the individual has a definite length of life, so have species a definite duration. No one can have marvelled more than I have done at the extinction of species. When I found in La Plata the tooth of a horse embedded with the remains of *Mastodon*, *Megatherium*, *Toxodon*, and other extinct monsters, which all co-existed with still living shells at a very late geological period, I was filled with astonishment; for, seeing that the horse, since its introduction by the Spaniards into South America, has run wild over the whole country and has increased in numbers at an unparalleled rate, I asked myself what could so recently have exterminated the former horse under conditions of life apparently so favourable. But my astonishment was groundless. Professor Owen soon perceived that the tooth, though so like that of the existing horse, belonged to an extinct species. Had this horse been still living, but in some degree rare, no naturalist would have felt the least surprise at its rarity; for rarity is the attribute of a vast number of species of all classes, in all countries. If we ask ourselves why this or that species is rare, we answer that something is unfavourable in its conditions of life; but what that something is we can *hardly ever tell*. On the supposition of the fossil horse still existing as a rare species, we might have felt certain, from the analogy of all other mammals, even of the slow-breeding elephant, and from the history of the naturalisation of the domestic horse in South America, that under more favourable conditions it would in a very few years have stocked the whole continent. But we could not have told what the unfavourable conditions were which checked its increase, whether some one or several contingencies, and at what period of the horse's life, and in what degree they severally acted. If the conditions had gone on, however slowly, becoming less and less favourable, we assuredly should not have perceived the fact, yet the fossil horse would certainly have become rarer and rarer, and finally extinct;—its place being seized on by some more *successful* competitor.

It is most difficult always to remember that the increase of every creature is constantly being checked by unperceived hostile agencies; and that these same unperceived agencies are amply sufficient to cause rarity, and finally extinction. So little is this subject understood, that I have heard surprise repeatedly expressed at such great monsters as the Mastodon and the more ancient dinosaurians having become extinct; as if mere bodily strength gave *victory in the battle of life*. Mere size, on the contrary, would in some cases determine, as has been remarked by Owen, quicker *extermination* from the greater amount of requisite food. Before man inhabited India or Africa, some cause must have checked the continued increase of the existing elephant. A highly capable judge, Dr. Falconer, believes that it is chiefly insects which, from incessantly harassing and weakening the elephant in India, check its increase; and this was Bruce's conclusion with respect to the African elephant in Abyssinia. It is certain that insects and blood-sucking bats determine the existence of the

larger naturalized quadrupeds in several parts of S America

We see in many cases in the more recent tertiary formations that rarity precedes extinction and we know that this has been the progress of events with those animals which have been exterminated either locally or wholly through man s agency I may repeat what I published in 184 namely that to admit that species generally become rare before they become extinct—to feel no surprise at the rarity of a species and yet to marvel greatly when the species ceases to exist is much the same as to admit that sickness in the individual is the forerunner of death—to feel no surprise at sickness but when the sick man dies to wonder and to suspect that he died by some deed of violence

The theory of natural selection is grounded on the belief that each new variety and ultimately each new species is produced and maintained by having some advantage over those with which it comes into competition and the consequent extinction of the less favoured forms almost inevitably follows It is the same with our domestic productions when a new and slightly improved variety has been raised it at first supplants the less improved varieties in the same neighbourhood when much improved it is transported far and near like our short horn cattle and takes the place of other breeds in other countries Thus the appearance of new forms and the disappearance of old forms both those naturally and those artificially produced are bound together In flourishing groups the number of new specific forms which have been produced within a given time has at some periods probably been greater than the number of the old specific forms which have been exterminated but we know that species have not gone on indefinitely increasing at least during the later geological epochs so that looking to later times we may believe that the production of new forms has caused the extinction of about the same number of old forms

The competition will generally be most severe as formerly explained and illustrated by examples between the forms which are most like each other in all respects Hence the improved and modified descendants of a species will generally cause the extermination of the parent species and if many new forms have been developed from any one species the nearest allies of that species i e the species of the same genus will be the most liable to extermination Thus as I believe a number of new species descended from one species that is a new genus comes to supplant an old genus belonging to the same family But it must often have happened that a new species belonging to some one group has seized on the place occupied by a species belonging to a distinct group and thus have caused its extermination If many allied forms be developed from the successful intruder many will have to yield their places and it will generally be the allied forms which will suffer from some inherited inferiority in common But whether it be species belonging to the same or to a distinct class which have yielded their places to other modified and improved species a few of the sufferers may often be preserved for a long time from being fitted to some peculiar line of life or from inhabiting some distant and isolated station where they will have escaped severe competition For instance some species of *Trigonia* a great genus of shells in the secondary formations survive in the [illegible]

[illegible]

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[illegible]

slow extermination Moreover when by sudden immigration or by unusually rapid development many species of a new group have taken possession of an area [illegible] of the older [illegible] in a cor[illegible] the forms [illegible] places will commonly be allied for they will partake of the same inferiority in common

Thus as it seems to me the manner in which single species and whole groups of species become extinct accords well with the theory of natural selection We need not marvel at extinction if we must marvel let it be at our own presumption in imagining for a moment that we understand the many complex contingencies on which the existence of each species depends If we forget for an instant that each species tends to increase inordinately and that some check is always in action yet

seldom perceived b us, the whole economy of nature will be tt rl obscured. When we can precisel say why this species is more abundant in individuals than that why this species and not anoth can be naturalised in a en country then, and not until then, we ma justly feel surprise why we cannot account for the extinction of any particular species or group of species.

On the Forms f L fe cha ging almost simultaneously thro ghout the W orld

Scarcely any palæontological disco ery is more strikin than th fact that th forms of lif chang almost simultaneously thro ghout the world. Thus our European Chalk f rmation can be recognised in many distant regions, under the most different climates, where not a fragment of th min ral chalk itself can be found namely in N rth America, in equat rial South America, in Tierra del F ego, t the Cape of Good Hope and in th peninsula of India. For at these distant points, th rganic remains in certain beds present an unmistakable resemblance to those of the Chalk. It is not that th sam species are m t with f in some cases not n species is id ntically the same, b t th y belong to th sam families, genera, and sections of genera, and som times are similarl charact rised in su h trifling points as m re superficial sculpture M reo ther forms, which are not f und in th Chalk of Europe b t hich occur in th formations either abo below occur in the sam order at these distant points of th w rld. In th several ucces. palæozoic formations f Russia, West rn Europe, and North America, similar parallelism in th forms of lif has been observed b several thors so t is, ac cord ng to Ly ll, th th E ropean and North American tertiary deposits. E en if th few fossil species which are common to th Old and N w Worlds ere kept wholl o t of w th general parallelism in the successi forms of life, in the palæozoic and t rtiary tages, ould still be manifest, and the se ral formations could be easil correlated.

These observ tions, ho relat to the marine inhabitants of th world w ha not Sicient data to judg beth th produc tions of the land and of fresh w t t distant points change th sam parall l manne W ma doubt beth tl ha th hanged if the *M gatheri m Mylod Macrauchen a,* and *Toxod* had been brou t t Europe from La Plata, w hout any informatio in regard to th ir geological position, o one would ha e suspected that th had co-existed with sea-sh ll ll t ll li ing b t as these anomalous

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When th marine forms of lif are spoken of as having changed simultaneou ly thro gh ut the world t must not be pposed that this expression relates to th sam yea to the sam century n that t has a ery trict

...

resembled mo t closely those of th so th rn hemisph re So, again, se ral h ghly competent observers maintain that the xisting productions of th United States are m re closely related to those which li ed in Europe dur g *certain lat t rtiary ta es, than to the present* inhab tants of Europe and if this be so, t is id nt that fossilif rous beds w d pos ted on the shores of N rth America w uld h re after be liabl to be classed w th som what older E ropean beds. Ne erth less, lookin to remot ly f t re epoch, th re can be little d ubt that all th m re mod rn mar e f rmations, namely th ppe pliocene, th pleistocen and strictly modern beds of Europe N rth and South Am rica, and Australia, from containin fossil remains in som d gree allied, and from not in luding those f rms which are f und onl in th kl und l ing depos ts, w uld be correctly ranked as simultaneous in geological sense

Th fact of th forms of lif changin simultaneously in th abo e lar sense t distant parts of th w rld has greatly struck these admirable observ rs, MM de V rn uil and d Archiac. Aft ref rring to the parall lism of th palæozoic f rms of lif in various parts of Europe, they add If truck by this tran seq nce w turn our attention to N rth Am rica, and th re disco er a series of analogous phenomena, t will ppear certain that ll these modifications of pecies, th ir tinction, and the introduction of n w o es, cann t be ing to mere changes in marin curre ts o oth causes more o less local and temporary

larger naturalized quadrupeds in several parts of S. America.

We see in many cases in the more recent tertiary formations that rarity precedes extinction; and we know that this has been the progress of events with those animals which have been exterminated, either locally or wholly, through man's agency. I may repeat what I published in 1845, namely, that to admit that species generally become rare before they become extinct—to feel no surprise at the rarity of a species, and yet to marvel greatly when the species ceases to exist, is much the same as to admit that sickness in the individual is the forerunner of death—to feel no surprise at sickness, but, when the sick man dies, to wonder and to suspect that he died by some deed of violence.

The theory of natural selection is grounded on the belief that each new variety, and ultimately each new species, is produced and maintained by having some advantage over those with which it comes into competition; and the consequent extinction of the less favoured forms almost inevitably follows. It is the same with our domestic productions: when a new and slightly improved variety has been raised, it at first supplants the less improved varieties in the same neighbourhood; when much improved it is transported far and near, like our short-horn cattle, and takes the place of other breeds in other countries. Thus the appearance of new forms and the disappearance of old forms, both those naturally and those artificially produced, are bound together. In flourishing groups, the number of new specific forms which have been produced within a given time has at some periods probably been greater than the number of the old specific forms which have been exterminated; but we know that species have not gone on indefinitely increasing, at least during the later geological epochs, so that, looking to later times, we may believe that the production of new forms has caused the extinction of about the same number of old forms.

The competition will generally be most severe, as formerly explained and illustrated by examples, between the forms which are most like each other in all respects. Hence the improved and modified descendants of a species will generally cause the extermination of the parent species; and if many new forms have been developed from any one species, the nearest allies of that species, i.e. the species of the same genus, will be the most liable to extermination. Thus, as I believe, a number of new species descended from one species, that is a new genus, comes to supplant an old genus, belonging to the same family. But it must often have happened that a new species belonging to some one group has seized on the place occupied by a species belonging to a distinct group, and thus have caused its extermination. If many allied forms be developed from the successful intruder, many will have to yield their places; and it will generally be the allied forms, which will suffer from some inherited inferiority in common. But whether it be species belonging to the same or to a distinct class, which have yielded their places to other modified and improved [illegible]

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With respect to the apparently sudden extermination of whole families or orders, as of trilobites at the close of the palaeozoic period and of ammonites at the close of the secondary period, we must remember what has been already [illegible]

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Thus, as it seems to me, the manner in which single species and whole groups of species become extinct accords well with the theory of natural selection. We need not marvel at extinction; if we must marvel, let it be at our own presumption in imagining for a moment that we understand the many complex contingencies on which the existence of each species depends. If we forget for an instant that each species tends to increase inordinately, and that some check is always in action, yet

very difficult to account for considering the proximity of the two areas,—unless, indeed, it be assumed that an isthmus separated two seas inhabited by distinct, but contemporaneous, faunas. Lyell has made similar observations on some of the later tertiary formations. Barrande, also, shows that there is a striking general parallelism in the successive Silurian deposits of Bohemia and Scandinavia; nevertheless he finds a surprising amount of difference in the species. If the several formations in these regions have not been deposited during the same exact periods,—a formation in one region often corresponding with a blank interval in the other,—and if in both regions the species have gone on slowly changing during the accumulation of the several formations and during the long intervals of time between them; in this case the several formations in the two regions could be arranged in the same order, in accordance with the general succession of the forms of life, and the order would falsely appear to be strictly parallel; nevertheless the species would not be all the same in the apparently corresponding stages in the two regions.

On the Affinities of Extinct Species to each other, and to Living Forms.

Let us now look to the mutual affinities of extinct and living species. All fall into a few grand classes; and this fact is at once explained on the principle of descent. The more ancient any form is, the more, as a general rule, it

[illegible]

between them. That the extinct forms of life help to fill up the intervals between existing genera, families, and orders, is certainly true; but as this statement has often been ignored or even denied, it may be well to make some remarks on this subject, and to give some instances. If we confine our attention either to the living or to the extinct species of the same class, the series is far less perfect than if we combine both into one general system. In the writings of Professor Owen we continually meet with the expression of generalised forms, as applied to extinct animals; and in the writings of Agassiz, of prophetic or synthetic types; and these terms imply that such forms are in fact intermediate or connecting links. Another distinguished palaeontologist, M. Gaudry, has shown in the most striking manner that many of the fossil mammals discovered by him in Attica serve to break down the intervals between existing genera. Cuvier ranked the Ruminants and Pachyderms as two of the most distinct orders of mammals: but so many fossil links have been disentombed that Owen has had to alter the whole classification, and has placed certain pachyderms in the same sub-order with ruminants; for example, he dissolves by gradations the apparently wide interval between the pig and the camel. The Ungulata or hoofed quadrupeds are now divided into the even-toed or odd-toed divisions; but the *Macrauchenia* of S. America connects to a certain extent these two grand divisions. No one will deny that the *Hipparion* is intermediate between the existing horse and certain older ungulate forms. What a wonderful connecting link in the chain of mammals is the *Typotherium* from S. America, as the name given to it by Professor Gervais expresses, and which cannot be placed in any existing order. The Sirenia form a very distinct group of mammals, and one of the most remarkable peculiarities in the existing dugong and lamentin is the entire absence of hind limbs, without even a rudiment being left; but the extinct *Halitherium* had, according to Professor Flower, an ossified thigh-bone "articulated to a well-defined acetabulum in the pelvis," and it thus makes some approach to ordinary hoofed quadrupeds, to which the Sirenia are in other respects allied. The cetaceans or whales are widely different from all other mammals, but the tertiary *Zeuglodon* and *Squalodon*, which have been placed by some naturalists in an order by themselves, are considered by Professor Huxley to be undoubtedly cetaceans, "and to constitute connecting links with the aquatic carnivora."

Even the wide interval between birds and reptiles has been shown by the naturalist just quoted to be partially bridged over in the most unexpected manner, on the one hand, by the ostrich and extinct *Archeopteryx*, and on the other hand, by the *Compsognathus*, one of the Dinosaurians—that group which includes the most gigantic of all terrestrial reptiles. Turning to the Invertebrata, Barrande asserts, a higher authority could not be named, that he is every day taught that, although palaeozoic animals can certainly be classed under existing groups, yet that at this ancient period the groups were not so distinctly separated from each other as they now are.

Some writers have objected to any extinct species, or group of species, being considered as intermediate between any two living spe-

but depend on general laws which govern the whole animal kingdom M Barrande has made forcible remarks to precisely the same effect It is, indeed quite futile to look to changes of currents climate or other physical conditions as the cause of these great mutations in the forms of life throughout the world under the most different climates We must as Barrande has remarked look to some special law We shall see this more clearly when we treat of the present distribution of organic beings and find how slight is the relation between the physical conditions of various countries and the nature of their inhabitants

This great fact of the parallel succession of the forms of life throughout the world is explicable on the theory of natural selection New species are formed by having some advantage over older forms and the forms which are already dominant or have some advantage over the other forms in their own country give birth to the greatest number of new varieties or incipient species We have distinct evidence on this head in the plants which are dominant that is which are commonest and most widely diffused producing the greatest number of new varieties It is also natural that the dominant varying and far spreading species which have already invaded to a certain extent the territories of other species should be those which would have the best chance of spreading still further and of giving rise in new countries to other new varieties and species The process of diffusion would often be very slow depending on climatal and geographical changes on strange accidents and on the gradual acclimatisation of new species to the various climates through which they might have to pass but in the course of time the dominant forms would generally succeed in spreading and would ultimately prevail The diffusion would it is probable be slower with the terrestrial inhabitants of distinct continents than with the marine inhabitants of the continuous sea We might therefore expect to find as we do find a less strict degree of parallelism in the succession of the productions of the land than with those of the sea

Thus as it seems to me the parallel and taken in a large sense simultaneous succession of the same forms of life throughout the world accords well with the principle of new species having been formed by dominant species spreading widely and varying the new species thus produced being themselves dominant, owing to their having had some advantage over their already dominant parents, as well as over other species and again spreading, varying and producing new forms. The old forms which are beaten and which yield their places to the new and victorious forms, will generally be allied in groups from inheriting some inferiority in common and therefore as new and improved groups spread throughout the world old groups disappear from the world and the succession of forms everywhere tends to correspond both in their first appearance and final disappearance

There is one other remark connected with this subject worth making I have given my reasons for believing that most of our great formations rich in fossils, were deposited during periods of subsidence and that blank intervals of vast duration as far as fossils are concerned occurred during the periods when the bed of the sea was either stationary or rising and likewise when sediment was not thrown down quickly enough to embed and preserve organic remains During these long and blank intervals I suppose that the inhabitants of each region underwent a considerable amount of modification and extinction and that there was much migration from other parts of the world As we have reason to believe that large areas are affected by the same movement it is probable that strictly contemporaneous formations have often been accumulated over very wide spaces in the same quarter of the world but we are very far from having any right to conclude that this has invariably been the case and that large areas have invariably been affected by the same movements When two formations have been deposited in two regions during nearly but not exactly the same period we should find in both from the causes explained in the foregoing paragraphs the same general succession in the forms of life but the species would not exactly correspond for there will have been a little more time in the one region than in the other for modification extinction and immigration

I suspect that cases of this nature occur in Europe Mr Prestwich in his admirable Memoirs on the eocene deposits of England and in England with those in France, although he finds in both a curious accordance in the numbers of species belonging to the same genera, yet the species themselves differ in a manner

then the families which existed at the period marked VI. would certainly have differed from ach ther by a less number of characters for the would at this early tage f descent ha e di rged in a less d gree from th ir comm n pro nito Thus t comes that ancient and ex tinct genera are often in a greater o l ss d gree intermediate in character between th r modi fied descendants, r between th ir coll teral relations.

Under nature the process will be far more complicated than is represented in th diagram

expect, except in rare cases, t fill p th wid intervals in the natural yst m, and thus to unite distinct families rd rs. All that we ha a right to expect is, that those gro ps hich ha e, within known geol gical periods, und rgo m ch mod fication, should in th ld f rmati ns mak som slight pproach to each th so that th lder m mbers sh uld diff less from each the in some f th ir characters than d the existing members f the sam groups and thus by th co current e dence of ur best palæo tol gists is freq ntly th case

Thus, on the theory f desce t with mod fication, th main facts with respect t th m tual affinities of th tinct f rms of life to each th and to li ing f rms, are explained in satisfactory mann And th y are wholly inexplicable any th view

which succeeded t. Th th speci wh ch li ed t th sixth great tag f desce t in th diagram are the modified offspring f those hich li ed t th fifth stage, and are th par ts of those which becam till more modified at th se th tag h nce th y could hardly fail to be nearl t rmediate charact r be- t ee th f rms of lif abo and bel w W must, ho all w f th ture tinctio of som preced ng f rms, and in any regi n f th immigratio of ew forms from th regions, and f larg amo t of modifica- tion during th long and blank int rvals be- twee th su essi f rmations. S bject to these allowances, th f una of each geological

period und ubtedly int rmediate in char acter between th preceding and s cceeding f unas I need gi e nly one instance, nam ly the manne in which the foss ls f the De nian system, wh n this ystem was first disco ered w re t ce recognized by palæontol g ts as intermedi t in charact r between th se of the lying carboniferous, and und rl in Sil rian sy t ms. B t ach fauna s n t necessarily exactly int rmed te as unequal inter als f time have elapsed b tween consecuti e forma tions.

It is n real objection to th truth of the tat m t th t th fauna of each period as a wh le nearly int rmediate in character be- tween the preceding and succeeding f unas, that certain g nera ffer excepti ns t the rule. F instance the pecies of mastod ns and l phants, wh n arranged by D Falcon in tw series,—in the first place according to th ir m tual affinities, and in the second place ac cordi g t th period of existe ce,—do n t accord in arrang m nt. The pec s extreme in charact r are t th oldest o the mo t recent no are those which are intermed te in char act int rmedi te in ag But supposing f an instant, in this and oth r such cases, that

li that f rms success vely prod ced neces- sarily ndure f co *responding lengths f time.* A ry ancient form may occas onally ha e lasted m ch l er than a form elsewhere bseq tly produced, especially in the case

d mestic p geon w re arranged in serial affinity thus arrang m t w uld n t cl sely accord with th rd in turn of th ir prod ti n, and n l ss w th the rder f th disappearance f r th pare t rock p geon still li and many vari ti s b tween the rock p eon and the carri h becom tin t and carri rs which are treme in th important character f l gth f beak riginated arlier than short beaked tumbl rs, which are t th pposite end f th series in this respect.

Closely connected w th the tatem t, that th gam remains from an intermediate f rmati n are in som d gree intermediat in character is th fact, insisted n by all palæon tol gists, that f ssils from two consecuti formations are far m re closely related to each ther than are th fossils from tw remote

cies or groups of species If by this term it is meant that an extinct form is directly intermediate in all its characters between two living forms or groups the objection is probably valid But in a natural classification many fossil species certainly stand between living species and some extinct genera between living genera, even between genera belonging to distinct families The most common case especially with respect to very distinct groups such as fish and reptiles seems to be that supposing them to be distinguished at the present day by a score of characters the ancient members are separated by a somewhat lesser number of characters so that the two groups formerly made a somewhat nearer approach to each other than they now do

It is a common belief that the more ancient a form is by so much the more it tends to connect by some of its characters groups now widely separated from each other This remark no doubt must be restricted to those groups which have undergone m r l t the diffi for

t o v and then even a living animal as the Lepidosiren is discovered having affinities directed towards very distinct groups Yet if we compare the older reptiles and batrachians the older fish the older cephalopods, and the eocene mammals with the more recent members of the same classes we must admit that there is truth in the remark

Let us see how far these several facts and inferences accord with the theory of descent with modification As the subject is somewhat complex I must request the reader to turn to the diagram in the fourth chapter We may suppose that the numbered letters in italics represent genera and the dotted lines diverging from them the species in each genus The diagram is much too simple too few genera and too few species being given but this is unimportant for us The horizontal lines may represent successive geological fo r

a and f a closely allied family or sub family and o^{14} e m^{14} a third family These three families together with the many at net r a

their ancient progenitor On the princi l of the continued tendency to divergence of char

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rany differ from its ancient progenitor Hence we can understand the rule that the mo t ancient fossils differ most from existing forms We must not however assume that divergence of character is a necessary contingency it depends solely on the descendants from a species being thus enabled to seize on many and different places in the economy of nature Therefore it is quite possible as we have seen in the case of o S

t a u yet retain throughout a vast period the same general characteristics This is represented in the diagram by the letter F^{14}

All the many form t l t l d

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to a c endured to the present day

By looking at the diagram e

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c a o cr if for instance the genera a a^1 a^{10} f^{14} m^{14} m m were d interred these three families

l as a occurred with ruminants and certain pachyderms Yet he who objected to consider as intermediate the extinct genera which thus link together the living ge

ct forms If many extinct forms were to be discovered above one of the middle horizontal lines or geological formations—for instance above No VI—but none from beneath this line then only two of the families (those on the left hand a &c and b &c) would have to be united into one and there would remain two families, which would be less distinct from each other than they were before the discovery of the fossils So again if the three families formed of eight genera (a^{14} to m^{14}) on the uppermost line be supposed to differ from each other by half a dozen important characters,

and at what period the various forms of life first appeared, and this may well be disputed.

The problem whether organisation on the whole has advanced is in many ways excessively intricate. The geological record, at all times imperfect, does not extend far enough back to show with unmistakable clearness that within the known history of the world organisation has largely advanced. Even at the present day, looking to members of the same class, naturalists are not unanimous which forms ought to be ranked as highest: thus, some look at the selaceans or sharks, from their approach in some important points of structure to reptiles, as the highest fish; others look at the teleosteans as the highest. The ganoids stand intermediate between the selaceans and teleosteans; the latter at the present day are largely preponderant in number; but formerly selaceans and ganoids alone existed; and in this case, according to the standard of highness chosen, so will it be said that fishes have advanced or retrograded in organisation. To attempt to compare members of distinct types in the scale of highness seems hopeless; who will decide whether a cuttle-fish be higher than a bee—that insect which the great von Baer believed to be "in fact more highly organised than a fish, although upon another type"? In the complex struggle for life it is quite credible that crustaceans, not very high in their own class, might beat cephalopods, the highest molluscs; and such crustaceans, though not highly developed, would stand very high in the scale of invertebrate animals, if judged by the most decisive of all trials—the law of battle. Besides these inherent difficulties in deciding which forms are the most advanced in organisation, we ought not solely to compare the highest members of a class at any two periods—though undoubtedly this is one and perhaps the most important element in striking a balance—but we ought to compare all the members, high and low, at the two periods. At an ancient epoch the highest and lowest molluscoidal animals, namely, cephalopods and brachiopods, swarmed in numbers; at the present time both groups are greatly reduced, whilst others, intermediate in organisation, have largely increased; consequently some naturalists maintain that molluscs were formerly more highly developed than at present; but a stronger case can be made out on the opposite side, by considering the vast reduction of brachiopods, and the fact that our existing cephalopods, though few in number, are more highly organised than their ancient representatives. We ought also to compare the relative proportional numbers at any two periods of the high and low classes throughout the world: if, for instance, at the present day fifty thousand kinds of vertebrate animals exist, and if we knew that at some former period only ten thousand kinds existed, we ought to look at this increase in number in the highest class, which implies a great displacement of lower forms, as a decided advance in the organisation of the world. We thus see how hopelessly difficult it is to compare with perfect fairness under such extremely complex relations, the standards of organisation of the imperfectly known faunas of successive periods.

We shall appreciate this difficulty more clearly by looking to certain existing faunas and floras. From the extraordinary manner in which European productions have recently spread over New Zealand, and have seized on places which must have been previously occupied by the indigenes, we must believe that if all the animals and plants of Great Britain were set free in New Zealand, a multitude of British forms would in the course of time become thoroughly naturalised there, and would exterminate many of the natives. On the other hand, from the fact that hardly a single inhabitant of the southern hemisphere has become wild in any part of Europe, we may well doubt whether, if all the productions of New Zealand were set free in Great Britain, any considerable number would be enabled to seize on places now occupied by our native plants and animals. Under this point of view, the productions of Great Britain stand much higher in the scale than those of New Zealand. Yet the most skilful naturalist, from an examination of the species of the two countries, could not have foreseen this result.

Agassiz and several other highly competent judges insist that ancient animals resemble to a certain extent the embryos of recent animals belonging to the same classes; and that the geological succession of extinct forms is nearly parallel with the embryological development of existing forms. This view accords admirably well with our theory. In a future chapter I shall attempt to show that the adult differs from its embryo, owing to variations having supervened at a not early age, and having been inherited at a corresponding age. This process, whilst it leaves the embryo almost unaltered, continually adds, in the course of successive generations, more and more difference to the

formations Pictet gives as a well known instance the general resemblance of the organic remains from the several stages of the Chalk formation though the species are distinct in each stage This fact alone from its generality seems to have shaken Professor Pictet in his belief in the immutability of species He who is acquainted with the distribution of existing species over the globe will not attempt to account for the close resemblance of distinct species in closely consecutive formations by the physical conditions of the ancient areas having remained nearly the same Let it be remembered that the forms of life at least those inhabiting the sea, have changed almost simultaneously throughout the world and therefore under the most different climates and conditions Consider the prodigious vicissitudes of climate during the pleistocene period which includes the whole glacial epoch and note how little the specific forms of the inhabitants of the sea have been affected

On the theory of descent the full meaning of the fossil remains from closely consecutive formations being closely related though ranked as distinct species is obvious As the accumulation of each formation has often been interrupted and as long blank intervals have intervened between successive formations we ought not to expect to find as I attempted to show in the last chapter in any one or in any two formations all the intermediate varieties between the species which appeared at the commencement and close of these periods but we ought to find after intervals, very long as measured by years but only moderately long as measured geologically closely allied forms, or as they have been called by some authors representative species and these assuredly we do find We find in short, such evidence of the slow and scarcely sensible mutations of specific forms as we have the right to expect.

On the State of Development of Ancient compared with Living Forms

We have seen in the fourth chapter that the degree of differentiation and specialisation of the parts in organic beings when arrived at maturity is the best standard as yet suggested of their degree of perfection or highness We have also seen that, as the specialisation of parts is an advantage to each being so natural selection will tend to render the organisation of each being more specialised and perfect and in this sense higher not but that it may leave many creatures with simple and unimproved structures fitted for simple conditions of life and in some cases will even degrade or simplify the organisation yet leaving such degraded beings better fitted for their new walks of life In another and more general manner new species become superior to their predecessors for they have to beat in the struggle for life all the older forms with which they come into close competition We may therefore conclude that if under a nearly similar climate the eocene inhabitants of the world could be put into competition with the existing inhabitants the former would be beaten and exterminated by the latter as would the secondary by the eocene and the palæozoic by

organs modern forms ought on the theory of natural selection to stand higher than ancient forms Is this the case? A large majority of palæontologists would answer in the affirmative and it seems that this answer must be admitted as true though difficult of proof

It is no valid objection to this conclusion that certain brachiopods have been but slightly modified from an extremely remote geological epoch and that certain land and fresh water shells have remained nearly the same from the

tions of life and what could be better fitted for this end than these lowly organised Protozoa? Such objections as the above would be

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ifera, for instance could be proved to have first come into existence during the Laurentian epoch or the above brachiopods during the Cambrian formation for in this case there would not have been time sufficient for the development of these organisms up to the standard which they had then reached When advanced up to any given point, there is no

in the caves of Brazil, there are many extinct species which are closely allied in size and in all other characters to the species still living in South America; and some of these fossils may have been the actual progenitors of the living species. It must not be forgotten that, on our theory, all the species of the same genus are the descendants of some one species; so that, if six genera, each having eight species, be found in one geological formation, and in a succeeding formation there be six other allied or representative genera each with the same number of species, then we may conclude that generally only one species of each of the older genera has left modified descendants, which constitute the new genera containing the several species; the other seven species of each old genus having died out and left no progeny. Or, and this will be a far commoner case, two or three species in two or three alone of the six older genera will be the parents of the new genera: the other species and the other old genera having become utterly extinct. In failing orders, with the genera and species decreasing in numbers as is the case with the Edentata of South America, still fewer genera and species will leave modified blood-descendants.

Summary of the preceding and present Chapters

I have attempted to show that the geological record is extremely imperfect; that only a small portion of the globe has been geologically explored with care; that only certain classes of organic beings have been largely preserved in a fossil state; that the number both of specimens and of species, preserved in our museums, is absolutely as nothing compared with the number of generations which must have passed away *even during a single formation*; that, owing to subsidence being almost necessary for the accumulation of deposits rich in fossil species of many kinds, and thick enough to outlast future degradation, great *intervals* of time must have elapsed between most of our successive formations; that there has probably been more extinction during the periods of subsidence, and more variation during the periods of elevation, and during the latter the record will have been less perfectly kept; that each single formation has not been continuously deposited; that the duration of each formation is probably short compared with the average duration of specific forms; that migration has played an important part in the first appearance of *new forms in any one area and formation*; that widely ranging species are those which have varied most frequently, and have oftenest given rise to new species; that varieties have at first been local; and lastly, although each species must have passed through numerous transitional stages, it is probable that the periods, during which each underwent modification, though many and long *as measured by years*, have been short in comparison with the periods during which each remained in an unchanged condition. These causes, taken conjointly, will to a large extent explain why—though we do find many links—we do not find interminable varieties, connecting together all extinct and existing forms by the finest graduated steps. It should also be constantly borne in mind that any linking variety between two forms, which might be found, would be ranked, unless the whole chain could be perfectly restored, as a new and distinct species; for it is not pretended that we have any sure criterion by which species and varieties can be discriminated.

He who rejects this view of the imperfection of the geological record, will rightly reject the whole theory. For he may ask in vain where are the numberless transitional links which must formerly have connected the closely allied or representative species, found in the successive stages of the same great formation. He may disbelieve in the immense intervals of time which must have elapsed between our consecutive formations; he may overlook how important a part migration has played, when the formations of any one great region, as those of Europe, are considered; he may urge the apparent, but often falsely apparent, sudden coming in of whole groups of species. He may ask where are the remains of those infinitely numerous organisms which must have existed long before the Cambrian system was deposited? We now know that at least one animal did then exist; but I can answer this last question only by supposing that where our oceans now extend they have extended for an enormous period, and where our oscillating continents now stand they have stood since the commencement of the Cambrian system; but that, long before that epoch, the world presented a widely different aspect; and that the older continents, formed of formations older than any known to us, exist now only as remnants in a metamorphosed condition, or lie still buried under the ocean.

Passing from these difficulties, the other

adult Thus the embryo comes to be left as a sort of picture preserved by nature, of the former and less modified con lition of the spe cies This view may be true and yet may never be capable of proof Seeing for instance that the oldest known mammals reptiles and fishes strictly belong to their proper classes, though some of these old forms are in a slight degree less distinct from each other than are the typical members of the same groups at tl present d

ar beneath the lowest Cam brian strata—a discovery of which the chance is small

On the Succession of the same Types within the same Areas during the later Tertiary periods

Mr Clift many years ago showed that the fos il mammals from the Australian caves were closely allied to the living marsupials of that continent In South America a similar rela tionship is manifest even to an uneducated eye in the gigantic pieces of armour like those of the armadillo foun l in several parts of La Plata and Professor Owen has sl own in the most striking manner that most of the fossil mammals buried there in such numbers are related to South American types This rela tionship is even more clearly seen in the won derful collection of fos il bones made by MM Lund and Clausen in tl e caves of Brazil I was so much impres e l with these facts that I strongly insiste l in 1839 and 184 on this law of the succession of types —on this wonderful relationship in the same continent between the dead an l the living Professor Owen has sub equently extended the same generalisation to the mammals of the Ol l World We see the same l n tl

l same law holds good with sea sl ells but from the wide di tribution of most molluscs it is not well di played by tl m O l ases e ex and g brackish water shells of the Aralo-Ca p an Sea.

Now what does tl is remarkable law of the succession of the same types witl in the same areas mean? He would be a bold man who after comparing the pre ent climate of Aus tralia an l of parts of South America, under the same latitude woul l attempt to account, on the one hand through dissimilar physical con ditions, for the dissimilarity of the inhabitants of these two continents and on the other hand through similarity of conditions, for the u i formity of the same types in each continent during the later tertiary periods. Nor can it be pretended that it is an immutable law that marsupials should have been chiefly or solely produced in Australia or that Edentata and other American types sl o l l

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was formerly different from what it now is North America formerly partook strongly of the present character of the soutl ern half of the continent an l the southern half was f r merly more closely allied than it is at present to the northern half In a similar manner we know from Falconer an l Cautley s discoveries, that Northern India was formerly more closely related in its mammals to Africa than it is at the present time Analogous facts could be given in relation to the di tribution of marine animals

On the theory of descent with modification, the great law of the long enduring but not immutable succession of the same types witl n the same areas is at once explained for the inhabitants of each quarter of the worl l w ll obviously ten l to leave in that quarter durin the next ucceeding period of time closely allied though in some degree modified de scen lants If the inhabitants of one continent formerly differed greatly from those of anotl er continent, so will their modified descen lants still differ in nearly the same manner an l de gree But after very long in tervals of time and after great geographical changes permitting much intermigration the feebl r will yiel l to the more dominant forms, and there will be nothing immutable in the distribution of or ganic beings

It may l e asked in ridicule whether I sup pose that the *Megatherium* an l other allied huge monsters, wl ich formerly lived in South America, have left behin l them the sl tl armadillo an l anteater as tl eir degenerate d scen lant This cannot for an instant be admitted Tl ese l uge animals have become wholly extinct and l ave left no progeny But

CHAPTER XII

GEOGRAPHICAL DISTRIBUTION

In considering the distribution of organic beings over the face of the globe, the first great fact which strikes us is, that neither the similarity nor the dissimilarity of the inhabitants of various regions can be wholly accounted for by climatal and other physical conditions. Of late, almost every author who has studied the subject has come to this conclusion. The case of America alone would almost suffice to prove its truth; for if we exclude the arctic and northern temperate parts, all authors agree that one of the most fundamental divisions in geographical distribution is that between the New and Old Worlds; yet if we travel over the vast American continent, from the central parts of the United States to its extreme southern point, we meet with the most diversified conditions; humid districts, arid deserts, lofty mountains, grassy plains, forests, marshes, lakes and great rivers, under almost every temperature. There is hardly a climate or condition in the Old World which cannot be paralleled in the New—at least as closely as the same species generally require. No doubt small areas can be pointed out in the Old World hotter than any in the New World; but these are not inhabited by a fauna different from that of the surrounding districts; for it is rare to find a group of organisms confined to a small area, of which the conditions are peculiar in only a slight degree. Notwithstanding this general parallelism in the conditions of the Old and New Worlds, how widely different are their living productions!

In the southern hemisphere, if we compare large tracts of land in Australia, South Africa, and western South America, between latitudes 25° and 35°, we shall find parts extremely similar in all their conditions, yet it would not be possible to point out three faunas and floras more utterly dissimilar. Or, again, we may compare the productions of South America south of lat. 35° with those north of 25°, which consequently are separated by a space of ten degrees of latitude, and are exposed to considerably different conditions; yet they are incomparably more closely related to each other than they are to the productions of Australia or Africa under nearly the same climate. Analogous facts could be given with respect to the inhabitants of the sea.

A second great fact which strikes us in our general review is, that barriers of any kind, or obstacles to free migration, are related in a close and important manner to the differences between the productions of various regions. We see this in the great difference in nearly all the terrestrial productions of the New and Old Worlds, excepting in the northern parts, where the land almost joins, and where, under a slightly different climate, there might have been free migration for the northern temperate forms, as there now is for the strictly arctic productions. We see the same fact in the great difference between the inhabitants of Australia, Africa, and South America under the same latitude; for these countries are almost as much isolated from each other as is possible. On each continent, also, we see the same fact; for on the opposite sides of lofty and continuous mountain ranges, of great deserts and even of large rivers, we find different productions; though as mountain-chains, deserts, &c., are not as impassable, or likely to have endured so long as the oceans separating continents, the differences are very inferior in degree to those characteristic of distinct continents.

Turning to the sea, we find the same law

Echinodermata in common; but Dr. Günther has recently shown that about thirty per cent. of the fishes are the same on the opposite sides of the isthmus of Panama; and this fact has led naturalists to believe that the isthmus was formerly open. Westward of the shores of America, a wide space of open ocean extends, with not an island as a halting-place for emigrants; here we have a barrier of another kind, and as soon as this is passed we meet in the eastern islands of the Pacific with another and totally distinct fauna. So that three marine faunas range far northward and southward in parallel lines not far from each other, under corresponding climates; but from being separated from each other by impassable barriers, either of land or open sea, they are almost wholly distinct. On the other hand, proceeding still farther westward from the eastern islands of the tropical parts of the Pacific, we en

great leading facts in palæontology agree admirably with the theory of descent with modification through variation and natural selection We can thus understand how it is that new species come in slowly and successively how species of different classes do not necessarily change together or at the same rate or in the same degree yet in the long run that all undergo modification to some extent The extinction of old forms is the almost inevitable consequence of the productions of new forms We can understand why when a species has once disappeared it never reappears Groups of species increase in numbers slowly and

dominant species belonging to large and dominant groups tend to leave many modified descendants which form new sub groups and groups As these are formed the species of the less vigorous groups from their inferiority in

sometimes been a slow process from the survival of a few descendants lingering in protected and isolated situations When a group has once wholly disappeared it does not reappear for the link of generation has been broken

We can understand how it is that dominant forms which spread widely and yield the greatest number of varieties tend to people the world with allied but modified descendants and these will generally succeed in displacing the groups which are their inferiors in the struggle for existence Hence after long intervals of time the productions of the world appear to have changed simultaneously

We can understand how it is that all the forms of life ancient and recent make together a few grand classes We can understand from the continued tendency to divergence of character why the more ancient a form is the more it generally differs from those now living why ancient and extinct forms often tend to fill up gaps between existing forms sometimes blending two groups, previously classed as distinct into one but more commonly bringing them only a little closer together The more ancient a form is the more often it stands in some degree intermediate between groups now distinct for the more ancient a form is, the more nearly it will be related to and consequently resemble the common progenitor of groups since become widely divergent. Extinct forms are seldom directly intermediate between existing forms but are intermediate only by a long and circuitous course through other extinct and different forms We can clearly see why the organic remains of closely consecutive formations are closely allied for they are closely linked together by generation We can clearly see why the remains of an intermediate formation are intermediate in character

far higher in the scale and their structure has generally become more specialised and this may account for the common belief held by so many palæontologists that organisation on the whole has progressed Extinct and ancient animals resemble to a certain extent the embryos of the more recent animals belonging to the same classes and this wonderful fact receives a simple explanation according to our views The succession of the same types of structure within the same areas during the later geological periods ceases to be mysterious and is intelligible on the principle of inheritance

If then the geological record be as imperfect as many believe and it may at least be asserted that the record cannot be proved to be much more perfect the main objections to the theory of natural selection are greatly diminished or disappear On the other hand all the chief

supplanted by new and improved forms life the products of Variation and the Survival of the Fittest.

CHAPTER XII

GEOGRAPHICAL DISTRIBUTION

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We can thus understand how it is that new species come in slowly and successively how species of different classes do not necessarily change together or at the same rate or in the same degree yet in the long run that all undergo modification to some extent The extinction of old forms is the almost inevitable consequence of the *productions of new forms* We can understand why when a species has *once disappeared it never reappears* Groups of species increase in numbers slowly and endure for unequal periods of time for the process of modification is necessarily slow and depends on many complex contingencies The dominant species belonging to large and dominant groups tend to leave many modified descendants which form new sub groups and groups As these are formed the species of the less vigorous groups *from their inferiority inherited from a common progenitor* tend to *become extinct together and to leave no modified offspring on the face of the earth* But the utter extinction of a whole group of species has sometimes been a slow process from the survival of a few descendants lingering in protected and isolated situations When a group has once wholly disappeared it does not reappear for the link of generation has been broken

We can understand how it is that dominant forms which spread widely and yield the greatest number of varieties tend to people the world with allied but modified descendants and these will generally succeed in displacing *the groups which are their inferiors* in the struggle for existence Hence after long intervals of time *the productions of the world appear* to have changed simultaneously

We can understand *how it is that all the* forms of life ancient and recent make together a few grand classes We can understand from the continued tendency to divergence of character why the more ancient a form is the more it generally differs from those now living why ancient and extinct forms often tend to fill up gaps between existing forms sometimes blending two groups, previously classed as distinct into one but more commonly bringing them only a little closer together The more ancient a form is the more often it stands in some degree intermediate between groups now distinct for the more ancient a form is, the more nearly it will be related to and consequently resemble the common progenitor of groups since become widely divergent Extinct forms are seldom directly intermediate *between existing forms* but are *intermediate* only by a long and circuitous course through other extinct and different forms We can clearly see why the organic remains of closely consecutive formations are closely allied for they are closely linked together by generation We can clearly see why the remains of an intermediate formation are intermediate in character

The inhabitants of the world at each successive period in its history have beaten their *predecessors in the race for life* and are in so far higher in the scale and their structure has *generally become more specialised* and this may account for the common belief held by so *many palæontologists that organisation on* the whole has progressed Extinct and ancient animals resemble to a certain extent the embryos of the more recent animals belonging to the same classes and this wonderful fact receives a simple explanation according to our views The succession of the same types of structure within the same areas during the later geological periods ceases to be mysterious and is intelligible on the principle of inheritance

more perfect, the main objections to the theory *of natural selection are greatly diminished* or disappear On the other hand all the chief

supplanted by new and improved forms of life the products of Variation and the Survival of the Fittest.

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Accord to th se ws, b ou that th ral pec es f th san g n s, th o gl nhab ting th most d tant q art rs f the w ld must ng all l proceeded from th sam source as th re d scended from th sam pro nt I th case f th se pe cies hich h un l rg d th wh le geolo cal pe od l ttl odific t n, th re is not m ch d ffi lt bel g th t th l migr ted from th sam reg f d ng tl ast geogr ph l and l m tal ch ang l ch ha pers ed ce an t t m s, lm t an am t f m gration is pos bl B t many th cases, wh ch h reaso t bel th t th pecies f g l bee prod ced th comparati ly rece t t m s, th re gre t d ffi lty n this h ad It is also b ious th t th d nd als f th sam pe ci s, th gh w inhab ting distant and iso lated regi ns, must h proceeded from pot, wh re th pare ts re first p od ced f as has bee plained t red bl th t d id al d t call th sam sl kl h bee p od ced from pare ts pecifi ally dis ti t

Single C t f pposed C at —W are thus bro ght t th q t which has been larg l discussed b nat alists, nam ly

ibl h m grated from som po t t th se ral d t t d sol ted po ts, wh w f d N th l th m l t f th w th t ach pec was first prod ced thu singl re capt t th m nd wh reject t reject th f rd nary g rat th s l seq t m grat n, and calls th f m l It sall admitted th t m t case th are m h t ted l pec es o tun and th t h pla t mal nhabit t t po t so d tant f m ach th w th an t rval f ch nat re th t th pace co ld t l bee eas l passed b m gratio th fact is g as som th ng markabl and cep tional. Th incapacity f migratin across a

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sam so th t a m lt t l f European an mal and plants l beco nat ral sed n A ca and Aust alia nd so t e f th aborig nal plants are d t lly th sa n at these d t nt points f th n th rn a l so thern hem s ph res. Th an as I bel e, s, th t mamm l l t been able to m grat wh reas som plants, from th r aried m f d persal h e m rated across the w brok t r spaces. Th gre t and trik g fl nce f barri rs of all k nds, th gibl le ly n th ew th t th gre t maj rit of peci ha bee prod ce l l h t bee abl to m g t t th pp site de So f fam l s, v sub-f l es, rs n g a, a f t th gre t r be f sect ns f g a, re co fi ed to a gl re io a f t t as bee bserved by se ral t alist th t th ost t ral g n ra, those ge ra in wh ch th pec are m t closel rel ted t ach oth are g rally co fi ed t th sam o try f they l e d ang that th an is co t s. What tra g mal t w ld be, f f rectly pposit r le w re t pre l, wh w g d w t t to th series, nan l to th ind d als f th sam pec s, a d th se had not been, t least at first, conf ed to som regi

H ce t seems t m as t l as to nan th nat al ts, th t th w of ach pec s h ving been prod ced area h and ha bseq th m grated from that re as far as ts po rs f m ration and b sist ce nd pa t and prese t condit permitted It probabl Undo btedl m cases occ wh h w cann t plain h th sam pec es co ld l passed from point t th th B t th geograp hical and l m tal l g wh ch has ce ta l occurred w th rece t geological t mes, t h d red d sco t th f m l co t ang f man pecies. So th t w re red ced t con d wh ther th ceptions to

counter no impassable barriers and we have innumerable islands as halting places or continuous coasts until after travelling over a hemisphere we come to the shores of Africa and over this vast space we meet with no well defined and distinct marine fauna Although so few marine animals are common to the above named three approximate faunas of eastern and western America and the eastern Pacific islands yet many fishes range from the Pacific into the Indian Ocean and many shells are common to the eastern [illegible] the I[illegible] almost

[illegible] third great fact partly included in the foregoing statement is the affinity of the productions of the same continent or of the same sea though the species themselves [illegible]

[illegible] naturalist in travelling for instance from north to south never fails to be struck by the manner in which successive groups of beings specifically distinct though nearly related replace each other He hears from closely allied yet distinct kinds of birds notes nearly similar and sees their nests similarly constructed but not quite alike with eggs coloured in nearly the same manner The plains near the Straits of Magellan are inhabited by one species of Rhea (American ostrich) and northward the plains of La Plata by another species of the same genus and not by a true ostrich or emu like those inhabiting Africa and Australia under the same latitude On these same plains of La Plata we see the agouti and bizcacha animals having nearly the same habits as our hares and rabbits and belonging to the same order of rodents but they plainly display an American type of structure We ascend the lofty peaks of the Cordillera and we find an alpine species of bizcacha we look to the water and we do not find the beaver or musk rat but the coypu and capybara rodents of the S American type Innumerable other instances could be given If we look to the islands off the American shore however much they may differ in geological structure the inhabitants are essentially American though they may be all peculiar species. We may look back to past ages, as shown in the last chapter and we find American types then prevailing on the American continent and in the American seas We see in these facts some deep organic bond throughout space and time over the same

[illegible]

The bond is simply inheritance that cause which alone as far as we positively know produces organisms quite like each other or as we see in the case of varieties nearly alike The dissimilarity of the inhabitants of different regions may be attributed to modification through variation and natural select[illegible]

[illegible] migration of the more dominant forms of life from one region into another having been more or less effectually prevented at periods more or less remote —on the nature and number of the former immigrants —and on the action of the inhabitants on each other in leading to th[illegible]

the most important of all relations Thus the high importance of barriers comes into play by checking migration as does time for the slow process of modification through natural selection Widely ranging species abounding in individuals which have already triumphed over many competitors in their own widely extended homes will have the best chance of seizing on new places when they spread into new countries In their new homes they will be exposed to new conditions and will frequently undergo further modification and improvement and thus they will become still further victorious and will produce groups of modified descendants On this principle of inheritance with modification we can understand how it is that sections of genera whole genera, and even families are confined to the same areas, as is so commonly and notoriously the case

There is no evidence as was remarked in the last chapter of the existence of any law of necessary development As the variability of each species is an independent property and will be taken advantage [illegible]

[illegible] in quantity If a number of species after having long competed with each other in their old home were to migrate in a body into a new and afterwards isolated country they would be little liable to modification for neither migration nor isolation in themselves effect anything These principles come into play only by

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continuity of range are so numerous and of so grave a nature, that we ought to give up the belief, rendered probable by general considerations, that each species has been produced within one area, and has migrated thence as far as it could. It would be hopelessly tedious to discuss all the exceptional cases of the same species, now living at distant and separated points; nor do I for a moment pretend that any explanation could be offered of many instances. But, after some preliminary remarks, I will discuss a few of the most striking classes of facts; namely, the existence of the same species on the summits of distant mountain ranges, and at distant points in the arctic and antarctic regions; and secondly (in the following chapter), the wide distribution of freshwater productions; and thirdly, the occurrence of the same terrestrial species on islands and on the nearest mainland, though separated by hundreds of miles of open sea. If the existence of the same species at distant and isolated points of the earth's surface, can in many instances be explained on the view of each species having migrated from a single birthplace; then, considering our ignorance with respect to former climatal and geographical changes and to the various occasional means of transport, the belief that a single birthplace is the law, seems to me incomparably the safest.

In discussing this subject, we shall be enabled at the same time to consider a point equally important for us, namely, whether the several species of a genus, which must on our theory all be descended from a common progenitor, can have migrated, undergoing modification during their migration, from some one area. If, when most of the species inhabiting one region are different from those of another region, though closely allied to them, it can be shown that migration from the one region to the other has probably occurred at some former period, our general view will be much strengthened; for the explanation is obvious on the principle of descent with modification. A volcanic island, for instance, upheaved and formed at the distance of a few hundreds of miles from a continent, would probably receive from it in the course of time a few colonists, and their descendants, though modified, would still be related by inheritance to the inhabitants of that continent. Cases of this nature are common, and are, as we shall hereafter see, inexplicable on the theory of independent creation. This view of the relation of the species of one region to those of another does not differ much from that advanced by Mr. Wallace, who concludes that "every species has come into existence coincident both in space and time with a pre-existing closely allied species." And it is now well known that he attributes this coincidence to descent with modification.

The question of single or multiple centres of creation differs from another though allied question,—namely, whether all the individuals of the same species are descended from a single pair, or single hermaphrodite, or whether, as some authors suppose, from many individuals simultaneously created. With organic beings which never intercross, if such exist, each species must be descended from a succession of modified varieties, that have supplanted each other, but have never blended with other individuals or varieties of the same species; so that at each successive stage of modification all the individuals of the same form will be descended from a single parent. But in the great majority of cases, namely, with all organisms which habitually unite for each birth, or which occasionally intercross, the individuals of the same species inhabiting the same area will be kept nearly uniform by intercrossing; so that many individuals will go on simultaneously changing, and the whole amount of modification at each stage will not be due to descent

difference and superiority to descent from any single pair, but to continued care in the selecting and training of many individuals during

centres of creation, I must say a few words on the means of dispersal.

Means of Dispersal

Sir C. Lyell and other authors have ably treated this subject. I can give here only the briefest abstract of the more important facts. Change of climate must have had a powerful influence on migration. A region now impassable to certain organisms from the nature of its climate, might have been a high road for migration, when the climate was different. I shall, however, presently have to discuss this branch of the subject in some detail. Changes of level in the land must also have been highly influential: a narrow isthmus now separates

two marin f unas s bm rge t, or l t t fo me ly h been s bm rged ard tl two faunas will w bl d t g th r m f , h H l l Where th sea n w

f aff ty between tl mammals inl ab ting lands w th those of tl e n are t co ti ent b g n part d t rm ned (as we sh ll l ereaft r see) by t l g tl of tl t rven ng ocean — these and tl er el fact are pposed to th ad ss of h prod g s geog ph cal , w tl tl rece t period are

ll wise with Am rica. Otl utho e

N r does tl l t u sally lean e compos t of s cl lands fa our the ad is sio tl t tl y are tl recks f s k n c t n nt — if th l ad or g nall ted as co t tal t rang s, som t l ast of tl islai l l l l bee f rmed lik tl r m tain mm ts, f gran te t tamorpl ic scl ts, ld f ss lif ro s and tl r rocks, in t ad f consist g f m re g d of v l anic tt r

d nce f gre t oscill t n tl l l f tl land se b t t f l ast l g tl pos t l t n. f co tin ts, as t ha ted tl m w tl tl rece t pe od to ach th d to tl se al t g

I bota cal ks, tl is tl t pla t is oft n t ted to be ll ad jt lf l l se nat b t th gre t l fac l t f r tran-po t ross tl sea m be sa d to be alm t wl lly Lr w t t l I tried w th Mr B k l y a d f peri ts, t was t e n known l w f seed co ld resi t th juri action of s w t T m ri rise l I und tl t ut l 87 kinds, 64 g m t l aft r an imm rsion f 28 d s, an l f w su ed an m rs n of 137 d ys. It d serve t ce tl t ce ta n rd rs w far m re j red tl otl rs m e Leg m s, w re tr ed and w tl cept II y re isted th salt w t l adly se en pe f th all ed rd s, H droph llaceæ nd P l m aceæ w re all killed by a m th s m rs F r co en ce sake I cl fl tried mall seed tl t tl p le fr t l as all f th se sa k f w d tl o ld t h be n fl ted acros w l pa f tl a, wl tl t tl y jured by th salt t Aft rd I t ed so l fru ts, p les, &c. and som f tl se fl ated f al g t m It r ll k wn wl t a l lf

f plants and f ma an mals d ring th migr t I tl co al-p od ocean h nk islands are w m ked b n gs f coral t ll t d g th m Wh t f lly admitted as t w ll som d y be that ach pec has proceeded f m gl t th place and wl n th co se f tim w k som tl g d fi t bo t tl f d tr b tio hall b nabled t pec l t w tl security th f m t f tl la d B t I d t b l th t t will be pro ed tl t w thi th ece t pe od m t f co ti ts h ch w ta d q t sepa t h bee co tin sly lm t co t ly nited with ach th and w th th m y xist g ocean sland Se ral facts d s- t b t — cl as tl gre t l ff th mar f as tl pp t des f almost ri co t t — th l se rel t n f tl t rtiary nl ab tar t f se al land an l seas t tl p se t nl b t ts, — tl d gree b ches f 94 j l t w th pe f t, nd to

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place them on sea water The majority sank rapidly but some which whilst green floated for a short time when dried floated much longer for instance ripe hazel nuts sank im mediately but when dried they floated for 90 days and afterwards when planted germi nated an asparagus plant with ripe berries floated for 3 days when dried it floated for 85 days and the seeds afterwards germinated the ripe seeds of *Helosciadium* sank in two days when dried they floated for above 90 days and afterwards germinated Altogether out of the 94 dried plants 18 floated for above 8 days and some of the 18 floated for a very much longer period So that as $\frac{4}{87}$ kinds of seeds germinated after an 3

t p ... / orten after being dried for above 28 days, we may conclude as far as any thing can be inferred from these scanty facts that the seeds of $\frac{14}{100}$ kinds of plants of any country might be floated by sea currents during 28 days and would retain their power of germination In Johnston's *Physical Atlas* the average rate of the several Atlantic cur rents is 33 miles per diem (se ... ts run ... on this ... ing to ... miles

o ... a to another country and when stranded if blown by an inland gale to a favourable spot would germinate

Subsequently to my experiments M Mar tens tried similar on ... but in a much bett r manner for he placed th ... eeds in a box in the actual sea so that they were alternately w t and exposed to the air like really floating plants He tried 98 seeds mostly different from mine but he chose many large fruits and likew is seeds from plants which live near the sea and this would have favoured both the av rage length of their flotation and their re i tance to the injurious action of the alt wat r On the other hand he did not previously dry the plants or branches with the fruit and this as we have seen would have cau ed ome of th m to have floated much longer The r sult was that $\frac{1}{8}$ of his seeds of diff rent kinds floated for 4 days, and were then capable of germina tion But I do not doubt that plants exposed to the waves would float for a less time than those protected from violent movement as in our experiments. Therefore it would perhap be safer to assume that the seeds of about $\frac{10}{100}$ plants of a flora, after having been dried could be floated across a space of sea 900 miles in width and would then germinate The fact of the larger fruits often floating longer than the small is interesting as plants with large seeds or fruit which as Alph de Candolle has s o n generally have restricted ranges, could hardly be tran ported by any other means.

Seeds may be occasionally tran ported in another manner Drift timber is thrown up on most islands even on those in the mid t of the widest oceans and the natives of the coral islands in the Pacific procure stones for their tools, solely from the roots of drifted trees, the e stones being a valuable royal tax I fi d that when irregularly shaped stones are em bedded in the roots of trees, small p rcels of earth are frequently enclo ed in their inter stices and behind them — so p rfectly that not a particle could be wa hed away during the longest tran port out of one mall porti n of earth thus *completely* enclo ed by the roots of an oak about 0 years old three dicotyledonous plants germinated I am cert un of the ac curacy of this ob ervation A ... I

... at many kind f ...

f ... immer ion in sea water but some taken out of the crop of a pigeon which had floated on artificial a water for 30 days, to my surpri e nearly all germinated

Living birds can hardly fail to be highly eff ctive agents in the t ... tion of se ds ... ow frequently ... gale to vast ... an We may safely as sume that under such circumstance their rate of flight would oft n be 3 mil s an hour and some authors have giv n a far higher estimate I have never seen an instance of nutritious eeds passing through the inte tin s f a bird but hard seeds of fruit pa s unin jured through even the ... organs f a turk y In the course of two month , I p ... d up in my gar den 12 kind of seed ... t f the excrement of mall birds and these ... perfect and some of them which were tried germinated But the following fact is more important the crops of birds do not secrete ... a ...

... positively assert that all the grains do not pass into the gizzard for t ... hours or even eighteen

hours. A bird in this int rval m ght easily be blown to the distance f ⌐00 miles, and hawks are known t look t for tired b rds, and tl contents of their t rn rops m ght thus readily get scatt red. Som h wks and wls bo t th pre whole and, afte an t rv l f from twel to tw ty hours, d rge pell ts, wh h, as I know from xperime ts mad n th Zoological Gardens, incl d seeds capabl f g rmination. Some seed of th oat, wh at, millet, canary h mp, l and beet g rminated after ha ing been from tw l t t ent ne hours in th t mach of d ff re t b rd of prey and two seed of beet grew aft h g bee th retained f t d s and f teen hours. Fresh-w ter fish, I fi d, t seed of man land and w ter plants fish are fre q tl dev red b b rds, and th th seed m ght be transported from place to place I f ⌐ced man kinds f seed t th tomachs of dead fish, and th g th ir bod to fish eagles, t ks, and pelicans these b rds, afte an int rval f man h rs, th rejected th seeds in pell ts passed th m th ir crement and se ral of these seed retai ed th pow f g rm nation. C rtai seeds, l w w re alw killed b this process.

Locusts are som times bl wn t great distances from the land I m self ca ght n 3 0 miles from th coast f Africa, and ha heard of th m ca g t t gre t d tances. Th Re R. T Low inf rmed r C L ll that No mbe 1844 warm of locusts isited th island f Madeira. Th w re co tless umbers, as thick as th flakes f now in th heaviest nowstorm, and t nded pwards as far as could be see w th t lescope During tw three d th l wly careered ro d and round in an imm nse llipse t lea t fi si miles in diam t and t n ht alighted th tall trees, which were complet ly coated with them Th th disappeared th sea, as dd nl as th had ppeared, and ha not ce sited th island. N w in parts f N tal t beli ed b som farm rs, th gh ins ffici t dence th t inj rious seeds are intro ced into th ir grass-land th dun left b th gre t flights f locust which often t th t country I conseq nce of this belief M Weale se t m in lett mall pack t f th dried pell ts, t f which I tracted nder th microscope se eral seeds, and raised from th m se grass plants, belo ging t tw pecies of tw g era. Hence warm of locu ts, uch as that which isited Madeira, might read l be th means of introd ci se ral kinds of plants into an island l ng far from th mai land.

Alth ough the beaks and feet of birds are ge rally cl an, arth sometimes adh res to th m o e case I remo ed sixty-one grains, and n anoth r case tw nty two grains of dry argillaceo arth from th foot of a partridg and n the earth there was a pebble as lar as tl seed of tch. H re is a bette case tl l of a woodcock was sent to me by a fri nd, with a littl cak of dry earth attached to the hank, weigh ng l nin grains and this co tai ed a seed of th toad rush (*Juncus b fo ius*) which g rm nated and flowered M N sland f Brit t who d ri g tl last f rt ars has paid *close attentio* to o m grat ry birds, inf rm me that l ha oft n h t wagtails (M tacillæ) wh at-ears, and whinchats (axicolæ) on their first arri al n o h res, bef re th y had al ghted nd he has se eral times noticed little cakes of arth ttached to tl r feet. Man facts co ld be howing h w *generally* so l is charged w h seed F r nstance Prof Newt n sent

and w hing si and a half ounces. Th arth had bee k pt fo three ars, b t wh n brok n, w t red and placed nd a bell glass, less than 8 plants pru g from t these con isted f l m nocot led ns, including the common oat, and t lea t ne kind of grass, and of 0 dicot led ns, which consisted, j dging from th g l s, of t least three distinct pecies. W th uch facts bef re us, can w d ubt th t th man b rd which are annuall blown b gal across great spaces of ocean, and which ann all migrat —f instance th millions of q ails across the Medit rran an— m t occasionall transport a f w seeds imbedded in dirt adh n to th ir feet or beaks B t I hall h to recur to this subject.

As *icebergs are known to be* som times loaded with rth and stones, and ha e n arried brushwood, bones, and th nest of a land b rd t can hardl be doubted that th y m t occasionall as ⌐ested by Ly ll, ha tran ported seed from o part to anoth f th arctic and antarctic regions and durin th Glacial period from o part f the n w t mperat regions t anoth In th Azores, from th lar mbe f plants commo to E rope in compariso w th th species n th other islands of th Atlantic, wh h tand n arer to th *mainland* and (as remarked by

Mr. H. C. Watson) from their somewhat northern character in comparison with the latitude, I suspected that these islands had been partly stocked by ice-borne seeds, during the Glacial epoch. At my request Sir C. Lyell wrote to M. Hartung to inquire whether he had observed erratic boulders on these islands, and he answered that he had found large fragments of granite and other rocks, which do not occur in the archipelago. Hence we may safely infer that icebergs formerly landed their rocky burthens on the shores of these mid-ocean islands, and it is at least possible that they may have brought thither some few seeds of northern plants.

Considering that these several means of transport, and that other means, which without doubt remain to be discovered, have been in action year after year for tens of thousands of years, it would, I think, be a marvellous fact if many plants had not thus become widely transported. These means of transport are sometimes called accidental, but this is not strictly correct: the currents of the sea are not accidental, nor is the direction of prevalent gales of wind. It should be observed that scarcely any means of transport would carry seeds for very great distances: for seeds do not retain their vitality when exposed for a great length of time to the action of sea water; nor could they be long carried in the crops or intestines of birds. These means, however, would suffice for occasional transport across tracts of sea some hundred miles in breadth, or from island to island, or from a continent to a neighbouring island, but not from one distant continent to another. The floras of distant continents would not by such means become mingled; but would remain as distinct as they now are. The currents, from their course, would never bring seeds from North America to Britain, though they might and do bring seeds from the West Indies to our western shores, where, if not killed by their very long immersion in salt water, they could not endure our climate. Almost every year, one or two land-birds are blown across the whole Atlantic Ocean, from North America to the western shores of Ireland and England; but seeds could be transported by these rare wanderers only by one means, namely, by dirt adhering to their feet or beaks, which is in itself a rare accident. Even in this case, how small would be the chance of a seed falling on favourable soil, and coming to maturity! But it would be a great error to argue that because a well-stocked island, like Great Britain, has not, as far as is known (and it would be very difficult to prove this), received within the last few centuries, through occasional means of transport, immigrants from Europe or any other continent, that a poorly-stocked island, though standing more remote from the mainland, would not receive colonists by similar means. Out of a hundred kinds of seeds or animals transported to an island, even if far less well-stocked than Britain, perhaps not more than one would be so well fitted to its new home, as to become naturalised. But this is no valid argument against what would be effected by occasional means of transport, during the long lapse of geological time, whilst the island was being upheaved, and before it had become fully stocked with inhabitants. On almost bare land, with few or no destructive insects or birds living there, nearly every seed which chanced to arrive, if fitted for the climate, would germinate and survive.

Dispersal during the Glacial Period

The identity of many plants and animals, on mountain-summits, separated from each other by hundreds of miles of lowlands, where Alpine species could not possibly exist, is one of the most striking cases known of the same species living at distant points, without the apparent possibility of their having migrated from one point to the other. It is indeed a remarkable fact to see so many plants of the same species living on the snowy regions of the Alps or Pyre-

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perched bould ■ f th treams w th which the all w re lat ly filled So greatly has th clim te f E rope hanged th t i north rn Ital g gant c m rain s, l ft by ld glaci rs, are now lotl ed by th vine and maize Thro gh t large part of the United tates, rr tic bo lders and sco ed ocks pla ly

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rope as xplained b Edward F be b- tant ally as f ll ws. B t w shall f ll w tl e hanges m re read ly by ppo ing ew glacial period l ly t com on, and tl n pass as f rm ly occu red As the cold m n, and as ach m re so th rn became fitted f the inhab tants f the rth these ld take the places f th f rm nhal tants f th t mpe t reg ns. Th latt at th sam tim w ld tra l f rth and fur th so thward nless th y w re topped by barr rs, in which case th y w ld perish The m untains w ld becom co red with sn w and ice and th ir f rm Alp nhab tants w ld d sce d t th plains. By th tum tl t th cold had reached ts ma imum w l ld h an arctic fauna and fl ra, co ring th ce tral parts f E rope as far so th as th Alps and P re ees, and tretch g to pain. Th w t mperat reg ns f th United States w ld like ise b co red by arct plants and animals and th se uld be n arly th sam w th th se f E rope f th prese t rcumpolar nhab tants, which w ppose to ha ywh re tra lled so thward are re markably unif rm d th w ld

As th armth ret rned th arctic f rm ld tre t thw rd, losely f ll wed b th retre t b ■ prod t ns f th m re t mpe t reg ns. And as th n w m lted from th base f the m tains, th arct c f rm w ld ze n th l ared and th ed ground alw asce di g as th warmth in reased and th sn w t ll f rthe d sappeared high and h gh whilst th ir brethre w re p uing th ir rth rn j rn y H ce wh n th warmth had fully returned th sam pe cies, h h had l t l h ed tog th n th European and N rth Am rican l wlands, w ld gain be f und th arcti reg ns f th Old and New W lds, and many iso- lated mountain mmit far d tant from ach th

Th w can u d rstand th dent ty f many plant t po ts so imm sely rem t as tl t s f th United States and those f E rope We can thu also understand tl fact tl t th Al e plar t f each m untain range are m re pec all rel ted t tl e arctic f rms h g d m tl or ly d n rtl of them f r th f t m grat wl n the cold cam n, and the re n g al n tl r turn g w mtl w ll g e all l a e been d so th and n rth Tl Al plar ts, f r ample f Scotlar l as remarked l y Mr H C W tson, a d th se f tl P r nees, as rem ked b Ram d re m re p cially all ed to tl plants of th rn Scand a ia tl ose of tl U ted States to Lal ad r tl se of tl e m t n f S ben t tl rct c regi of tl t

E rope an ...

g ns we fi d tl sam pec o d t t m tain mm ts, w may alm t 'or l l U t tl d nce tl t a cold cl mate f rm rly perm tted tl ir m g ation across tl e t rv m g l wl nds, n w become too w f tl e iste ce

As the arctic f rms m ed first so tl w rd a d aft rward backward to th north n uniso w th the changi g climate th y w ll n t h been e posed d ri th l g t n t any gre t d rsity of t mperat re and as th y all gr ted m a body t geth th m t al relat ns will n t ha been m l disturbed. H nce in accordance with th pri cipl in lcated in this l m these f rm w ll n t ha bee liable t m ch mod ficat o B t w th th Alpin prod t ns, l ft isolated from th m m t f tl turning warmtl

th sam arct e peci w ll l bee l ft n m tain ang f distant f m ach otl and ha urv ed there e r ce th y w ll also in all probab l t h becom m led w th anci nt Alpine pec s, wh h must h e isted n th t b f re th com m cem ■ f tl Glac al poch, and wh cl d ing th cold t pe od will l been t m porarily dri n d wn t th plains th y w ll also ha bee bseq ntly xposed to some wh t different cl matal infl ces. Th m tual rel t ns w ll th l e been in som d gree d t bed conseq ntly they w ll h been liabl to mod ficat n and th y h bee modified f f w mpare tl prese t Al o

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tant ally as f ll ws. B t w sh ll f llow the l anges m re r addly by ppo g n w glacial pe od sl ly t om n, and th pass y as f rm ly occurred A the cold came n, and as ach m re so th n o becam fitted f r th inl b tants f tl n rtl th se ld tak the place f the f rm inh l tant f th t mp t g ns. The l tt r t th sam tim w uld t el furth and f t w l l th w e topped by

w ld d se d t tl pl ins. By th t me tl t th cold had reached ts m imum we ho ld

Spain. Th w t mp t reg ns f the U ted States w ld likew se b co red by arcti plants and an mals and th se wo ld b arly th sam w th th se f E rope f th p se t rcumpolar nh b tants, wl ch w ppose t h y wh t lled m thward ar re m kably unif rm d th w ld

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Thus an und rstand th d t ty f many plant t points so imm nsely rem t as tl m unta ns f th United Stat d thos

of Eu fact t ra g form tl m fo tl e f rst migrati wl n tl e col l ca n, d tl re m g at o n tl n turn g w rm tl w ll g alls l a e been d south ard th The Alp pla ts, f r mpl f Scotla d as r mark d f Mr H C W tso d th f tl Pyr nees, as rei ked by Ra d are re pec ally ll ed to tl pla ts f n tl rn Scand na tl ose of tl United Stat t Lal ad n tl se of tl e o tn f S l t tl rct c reg n of th t

E rope u
g n we fi d tl e sam spec d t l m tai mm ts, we n ay alm t cor l l w tl ut tl r d ce tl t a cold r l m te forme ly p rm tted tl e m gration across tl e ter m g l lands w become too war

w ll t h been l abl to m d n od fic t If t w th tl Alp prod t ns, l ft isol ted f m th m m nt f tl e t rn g warmth first t th bas l ult m t ly t tl u m ts f th m tai is, the case w ll l bee som wl t d ff re t f t s n t l k ly th t ll th same arct pec w ll l been l ft n m tai ang far distant from ach tl and ha rvi ed th re nce tl y ll also in all prob l l ty h l ecom mingled w th anci nt Alpin pecies, wl h mu t l ted tl untai b f th com m cem t f th Gl l poch and wh cl d rin the cold t pe od will l a been t m po arily dri d wn t th plains they w ll also h bee bseq tl posed to some wh t diff t cl matal infl nces. Tl mut al l t ns w ll tl f been in som d gree dist rbed conseq tl tl y will h bee l bl to modifi t n an l th y l bee mod fied f f w comp tl prese t Alp e

plants and animals of the several great European mountain ranges one with another though many of the species remain identically the same, some exist as varieties, some as doubtful forms or sub-species, and some as distinct yet closely allied species representing each other on the several ranges.

In the foregoing illustration I have assumed that at the commencement of our imaginary Glacial period the arctic productions were as uniform round the polar regions as they are at the present day. But it is also necessary to assume that many sub-arctic and some few temperate forms were the same round the world, for some of the species which now exist on the lower mountain slopes and on the plains of North America and Europe are the same; and it may be asked how I account for this degree of uniformity in the sub-arctic and temperate forms round the world, at the commencement of the real Glacial period. At the present day the sub-arctic and northern temperate productions of the Old and New Worlds are separated from each other by the whole Atlantic Ocean and by the northern part of the Pacific. During the Glacial period, when the inhabitants of the Old and New Worlds lived farther southward than they do at present, they must have been still more completely separated from each other by wider spaces of ocean; so that it may well be asked how the same species could then or previously have entered the two continents. The explanation, I believe, lies in the nature of the climate before the commencement of the Glacial period. At this, the newer Pliocene period, the majority of the inhabitants of the world were specifically the same as now, and we have good reason to believe that the climate was warmer than at the present day. Hence we may suppose that the organisms which now live under latitude 60°, lived during the Pliocene period farther north under the Polar Circle, in latitude 66°-67°; and that the present arctic productions then lived on the broken land still nearer to the pole. Now, if we looked at a terrestrial globe, we see under the Polar Circle that there is almost continuous land from western Europe, through Siberia, to eastern America. And *this continuity of the circumpolar land*, with the consequent freedom under a more favourable climate for intermigration, *will account for the supposed uniformity* of the sub-arctic and temperate productions of the Old and New Worlds, at a period anterior *to the Glacial epoch*.

Believing, from reasons before alluded to, that our continents have long remained in nearly the same relative position, though subjected to great oscillations of level, I am strongly inclined to extend the above view, and to infer that during some still earlier and still warmer period, such as the older Pliocene period, a large number of the same plants and animals inhabited the almost continuous circumpolar land; and that these plants and animals, both in the Old and New Worlds, began slowly to migrate southward as the climate became less warm, long before the commencement of the Glacial period. We now see, as I believe, their descendants, mostly in a modified condition, in the central parts of Europe and the United States. On this view we can understand the relationship with very little identity, between the productions of North America and Europe,—a relationship which is highly remarkable, considering the distance of the two areas, and their separation by the whole Atlantic Ocean. We can further understand the singular fact remarked on by several observers that the productions of Europe and America during the later tertiary stages were more closely related to each other than they are at the present time; for during these warmer periods the northern parts of the Old and New Worlds will have been almost continuously united by land, serving as a bridge, since rendered impassable by cold, for the intermigration of their inhabitants.

During the slowly decreasing warmth of the Pliocene period, as soon as the species in common, which inhabited the New and Old Worlds, migrated south of the Polar Circle, they will have been completely cut off from each other. This separation, as far as the more temperate productions are concerned, must have taken place long ages ago. As the plants and animals migrated southwards, they will have become mingled in the one great region with the native American productions, and *would have had to* compete with them; and in the other great region, with those of the Old World. Consequently we have here everything favourable for much modification,—for far more modification than with the Alpine productions, left *isolated, within a much more recent period*, on the several mountain ranges and on the arctic lands of Europe and N. America. Hence it has come, that when we compare the now living productions of the temperate regions of the New and Old Worlds, we find very few identical species (though Asa Gray has lately

shown that more plants are identical than was formerl supposed) b t w find m rv gre t class man forms, which som naturalists rank as geographical races, and oth rs as distinct species and host of losel allied or representative forms which are ranked by all naturalists as specificall d tinct.

As on th land, so in th w t rs of th sea, a low southern migration of a mar e fauna, which, during the Pliocen o en a somewhat earlier period, was nearly uniform along the continuous shores of th Polar Circle, will

can understand the presence of som closely allied, still xisting and xtinct tertiary forms, on the east rn and west rn shores of t mperate North America and th till more triking fact of m losel allied crustaceans (as

two areas ... the breadth of whol continent and b wal spaces of ocean.

These cases of close relationship in pecies either now f rm rl inhab ting th seas on the eastern and west rn shores of N rth America, the Mediterranean and Japan, and the temperat land of North Am rica and Europe are inexplicab the theory of cre tion. W cannot maintain that such pecies ha been created alike in correspond nce with the n arly imilar ph sical conditions of th areas for if w compare f instance certain parts of South America with parts of South Africa or Australia, w see countries closel similar in all th ir ph sical conditions, with th ir inhabitants tt rl dissimilar

Alterna e Gl al Periods n the North and South

B t w must return to our more immediat subject. I am convinced that F rbes view ma be largel extended In Europe w meet with th plainest idence of th Glacial period, from th west rn shores of Britain to the Oural range and southward t the P renees. W ma inf from th froze mammals and nature of th m untain egetation, that Siberia was similarl affected. In th Lebanon, according to Dr Hooker perpetual snow f merl co ered th central axis, and fed glaciers which rolled 400 feet d wn th valle s. Th same observer has recently found great moraines t l w l el n the Atlas range in N Africa. Along th Himala a, t points 900 miles part, glac rs ha l ft th marks of their former low descent and in Sikkim, Dr Hooker saw maize growi on ancient and gigantic moraines. So thward of the Asiatic contine t, n th pposite side of th equator we know from th excelle t researc es of Dr J Haast and Dr Hect r that in New Zealand immense glaci s form ly descended to a low le l and th same plants f und by D Hook n widely separated mountains in this island t ll th sam tory of a form r cold period From facts communicated to me by th R v W B Clark ppears also that th re are traces of form glacial action on th mountains of the so th-eastern corner of Australia.

Lookin to Am rica in th north rn half ice-born fragments of rock have been observed on th east rn side of the co tin nt, as far so th as lat. 36°-37° and on the shores of the Pacific, wh re the climate is now so diff rent, as far south as lat. 46° Erratic bould rs ha e also, been noticed o th Rocky Mountains. In th Cordillera of South Am rica, nearly und th equator glaciers once t nded far below their present le el. I Central

nforms m that h found in arious part of th Cordillera, from lat. 13° to 30° S., t also th h ght of 1,000 feet, deeply f rro ed rocks, resembling those w th which h w familiar in Norw y and likewise great ma ses of d tritus, including groo ed pebbles. Along this whole pace of th Cordillera true glac rs do not xi t ven t m ch more considerable heights. Farth south n both sides of th contin t, from lat. 41 to the so thernmost xtremity w ha th clearest vid nce of form glacial action, in um rous imm nse boulders transported far from their pare t source

From these se ral facts, nam ly from th glacial action h ving ext nded all round th northern and so th rn h mispheres—from the period having been in geological sense recent in both h misph res—from its having la ted in both during a great length of time, as ma be inf rred from th amount of work affected—and lastl from glac rs having recently descended to a low le l alo the whole lin of the Cordillera, t t on tim ppeared to me that w could not oid the conclusion that

the temperature of the whole world had been simultaneously lowered during the Glacial period. But now Mr. Croll, in a series of admirable memoirs, has attempted to show that a glacial condition of climate is the result of various physical causes, brought into operation by an increase in the eccentricity of the earth's orbit. All these causes tend towards the same end; but the most powerful appears to be the indirect influence of the eccentricity of the orbit upon oceanic currents. According to Mr. Croll, cold periods regularly occur every ten or fifteen thousand years; and these at long intervals are extremely severe, owing to certain contingencies, of which the most important, as Sir C. Lyell has shown, is the relative position of the land and water. Mr. Croll believes that the last great Glacial period occurred about 240 000 years ago, and endured with slight alterations of climate for about 160 000 years. With respect to more ancient Glacial periods, several geologists are convinced from direct evidence that such occurred during the Miocene and Eocene formations, not to mention still more ancient formations. But the most important result for us, arrived at by Mr. Croll, is that whenever the northern hemisphere passes through a cold period the temperature of the southern hemisphere is actually raised, with the winters rendered much milder, chiefly through changes in the direction of the ocean currents. So conversely it will be with the northern hemisphere, whilst the southern passes through a Glacial period. This conclusion throws so much light on geographical distribution that I am strongly inclined to *trust in it; but I will first give the facts which* demand an explanation.

In South America, Dr. Hooker has shown *that besides many closely allied species,* between forty and fifty of the flowering plants of Tierra del Fuego, forming no inconsiderable part of its scanty flora, are common to North America and Europe, enormously remote as these areas in opposite hemispheres are from each other. On the lofty mountains of equatorial America a host of peculiar species belonging to European genera occur. On the Organ mountains of Brazil some few temperate European, some Antarctic and some Andean genera were found by Gardner which do not exist in the low intervening hot countries. On the Silla of Caraccas the illustrious Humboldt long ago *found species* belonging to genera characteristic of the Cordillera.

In Africa, several forms characteristic of Europe and some few representatives of the flora of the Cape of Good Hope occur in the mountains of Abyssinia. At the Cape of Good Hope a very few European species, believed not to have been introduced by man, and on the mountains several representative European forms are found which have not been *discovered in the intertropical parts of Africa.* Dr. Hooker has also lately shown that several of the plants living on the upper parts of the lofty island of Fernando Po and on the neighbouring Cameroon mountains, in the Gulf of Guinea, are closely related to those on the mountains of Abyssinia, and likewise to those of temperate Europe. It now also appears, as I hear from Dr. Hooker, that some of these same *temperate plants have been discovered* by the Rev. R. T. Lowe on the mountains of the Cape Verde Islands. This extension of the same temperate forms, almost under the equator, across the whole continent of Africa and to the mountains of the Cape Verde Archipelago, is one of the most astonishing facts ever recorded in the distribution of plants.

On the Himalaya, and on the isolated mountain ranges of the peninsula of India, on the heights of Ceylon, and on the volcanic cones of Java, many plants occur either identically the same or representing each other, and at the same time representing plants of Europe not found in the intervening hot lowlands. A list of the genera of plants collected on the loftier peaks of Java raises a picture of a collection made on a hillock in Europe! Still more striking is the fact that peculiar Australian forms are represented by certain plants growing on the *summits of the mountains of Borneo.* Some of these Australian forms, as I hear from Dr. Hooker, extend along the heights of the peninsula of Malacca, and are thinly scattered on the one hand over India, and on the other hand as far north as Japan.

On the southern mountains of Australia, Dr. F. Müller has discovered several European species; other species, not *introduced by man,* occur on the lowlands; and a long list can be

large island. Hence we see that certain plants growing on the more lofty mountains of the tropics in all parts of the world, and on the temperate plains of the north and south are

eith th sam pec o n t s f tl sam spec es It sh ld l o e e be bser ed th t these l t n t tr tly arct c f rms f r as M g f tl e less and l ss Arc and cl sely all ed forms, n any pecie in hab t g th sam w d ly d red areas, be l ngtog a tnowf d tl te med ate trop cal l wlands.

Th se bri f remarks pply t pl nts al n b t some f anal g fact co ld be g in regard t terrestrial an mal I m t pro d t ns m l cases l k w se occ r as an ampl I m y q t a tat m nt by tle h gl t th nty Prof Dana, th t It i ce ta ly a w d rful fact tl t N w Z al l

f N w Ze l nd Tasm a, &c f n rtl rn f rms f fi l D Hook nf rm m tl t t t fi pec l Alg com n n to N w Zealand and to E rope l t l t bee f d th t med te t p cal seas.

From th f g g fact nam ly tl s ce f t mpe t f m th h ghlands acro th wh le f eq torial Af ca, and al g th P ns la f Ind a, t C ylo and tl M l trel pelag d n les w ll marked an acro th w d pans f trop cal So th Am rica, t ppears lm t certa th t t som f m period n d bt d in th m tse p rt f Glacial pe od tl l wl d f th so g t co t ts w y h t nanted nd tl q to by a cons d bl umbe of t mpe t f rms. At tl is period th eq tori l lim t t tl l l f th was p b bly abo t tl sa w th th t w pen ced t th h ght f from t th usand feet u d r th m lati t d pe h p th cool D n g th s, th cold t pe od, th l wland d th equato must l bee l thed w th m gled tr p cal d t mpe t g tati n, l k that d scr bed by Hook as grow g l rnantly th h ght f from f to fi th d f t th l l pe f tl H malaya, b t w tl pe l p tl gr t p pond ance f tem pe t f ms. So agai th m t isla d f F rnand Po, th Gulf f G a, M Man f d t mpe t E ropean f ms beginni g to pp ar t th h gl t f ab fi th sa d f t O tl m t f Panama,

at th l lt f o ly two tl usand feet, D See M m n t

N w l t us see wl tl er Mr Croll co clu tl twl the rtl ernl e sph re ff red fro tl e e tre e col l f tl great Glac l per od tl so th rn l m pl re was act lly warm tl ro s ary cl r l gl t tl p s t apparently t xpl bled t b t of vari ga m the t pe f part f botl l m sph es, a d n tle m ntains of tl t p s. Tl e Glaci l pe i l as n as red by y ars, m tl y been ry l g n l wl n e

f any am t f grat n. A tl cold be came re an l m re tense w k w tl t arct f rm aded tl e t pe te regi ns and fr m th fact j t g n, tl can l ardly

same time ha e g t d t tl trop al and b tro p cal regi f tl so tl f rtl e so th ern h m pl a. t tl is period warm On tl decli f tl Glacial period n botl l m pl re g ad all reco red tl f rm t m perat res, th tl te pe te f rm l g on tl l wl d l tl eq tor would l y been d i n t tl r f rm l m s o l been d st yed l g replaced l y the eq torial f m r t g f the so tl Som h f tl tl m t pe t f rm s w ld alm t e t nly l asc ded a y adj m g h gl la l where f ff ntl l fty tl ey w ld l l g m d l k tl arct f rm tl m t ns of E rope Th y m ght l a e urv ed n if the l te was t pe fectly fitted f tl em f r tl e cl ang f t mper tur m t l bee low a d plants nd btedly posse s a ce t n y acty f accl m tisat as l n by th r t m tt g t tl off g diff nt co t tu t l pow f ist ng l t l cold

I tl r g l rse f t tl so tl ern l m ph w ld i ts t m be bjected to a se Glaci l pe od w th tl tl rn h m ph re d ed arme d tl tl south te pe te f rm w ld ad th eq a torial l wlands. Tl orth rn f m wl ch had bef re b l ft th m nt w ld n w d sc d and m gl w tl th so th n f ms

These latter, when the warmth returned, would return to their former homes, leaving some few species on the mountains, and carrying southward with them some of the northern temperate forms which had descended from their mountain fastnesses. Thus we should have some few species identically the same in the northern and southern temperate zones and on the mountains of the intermediate tropical regions. But the species left during a long time on these mountains, or in opposite hemispheres, would have to compete with many new forms and would be exposed to somewhat different physical conditions; hence they would be eminently liable to modification, and would generally now exist as varieties or as representative species; and this is the case. We must also bear in mind the occurrence in both hemispheres of former Glacial periods; for these will account, in accordance with the same principles, for the many quite distinct species inhabiting the same widely separated areas, and belonging to genera not now found in the intermediate torrid zones.

It is a remarkable fact, strongly insisted on by Hooker in regard to America, and by Alph. de Candolle in regard to Australia, that many more identical or slightly modified species have migrated from the north to the south than in a reversed direction. We see, however, a few southern forms on the mountains of Borneo and Abyssinia. I suspect that this preponderant migration from the north to the south is due to the greater extent of land in the north, and to the northern forms having existed in their own homes in greater numbers, and having consequently been advanced through natural selection and competition to a higher stage of perfection, or dominating power, than the southern forms. And thus, when the two sets became commingled in the equatorial regions, during the alternations to the Glacial periods, the northern forms were the more powerful and were able to hold their places on the mountains, and afterwards to migrate southward with the southern forms; but not so the southern in regard to the northern forms. In the same manner at the present day we see [illegible] two or three centuries from La Plata, and during the last forty or fifty years from Australia. The Neilgherrie mountains in India, however, offer a partial exception; for here, as I hear from Dr. Hooker, Australian forms are rapidly sowing themselves and becoming naturalised. Before the last great Glacial period, no doubt the intertropical mountains were stocked with endemic Alpine forms; but these have almost everywhere yielded to the more dominant forms generated in the larger areas and more efficient workshops of the north. In many islands the native productions are nearly [illegible]

[illegible] islands on the land, and their inhabitants have yielded to those produced within the larger areas of the north, just in the same way as the inhabitants of real islands have everywhere yielded and are still yielding to continental forms naturalised through man's agency.

The same principles apply to the distribution of terrestrial animals and of marine productions, in the northern and southern temperate zones, and on the intertropical mountains. When, during the height of the Glacial period, the ocean currents were widely different to what they now are, some of the inhabitants of the temperate seas might have reached the equator; of these a few would perhaps at once be able to migrate southward, by keeping to the cooler currents, whilst others might remain and survive in the colder depths until the southern hemisphere was in its turn subjected to a glacial climate and permitted their further progress; in nearly the same manner as, according to Forbes, isolated spaces inhabited by arctic productions exist to the present day in the deeper parts of the northern temperate seas.

I am far from supposing that all the difficulties in regard to the distribution and affinities of the identical and allied species, which now live so widely separated in the north and south, and sometimes on the intermediate mountain ranges, are removed on the views above given. The exact lines of migration cannot be indicated. We cannot say why certain species and not others have migrated; why certain species have been modified and have given rise to new forms, whilst others have remained unaltered. We cannot hope to explain such facts, until we can say why one species and not another becomes naturalised by man's agency in a foreign land; [illegible] species

ranges twice thrice as far and is tw ce r thrice as common, as an th r species w thin their wn homes.

Variou special difficulties also remain to be sol ed for instance th occurrence as sh wn b D Hooke of th sam plant at points so enormously remot as K rguel n Land, N w Zealand, and Fuegia b t icebergs, as suggested b L ll, may ha bee co cern d in th ir dispersal. The xistence at these and othe distant points of th so th rn h misph re of species, which, th gh dist ct, bel g to genera xclusi el confined t th so th, is a more remarkabl case Som of these pec es are so distinct, that we cann t ppose that there has bee tim nce th comm ncem nt of th last Glacial period f r th ir migrati n and subsequent modifi t t th necessary d gree. Th facts seem t ind cate that distinct species belo ging to th sam g nera ha migrated in radiating lines from comm centre and I am inclined to look in th so th rn, as in the north rn h m ph re to a form and warm period bef re th comm ncem t of th last Glacial period, wh th Antarctic lands, n w co red w th ice, suppo ted h hl peculiar and isolated flora. It ma be u pected that before this flora was xt rminated d n g th last Glacial poch, f w f rms had bee already wid di persed to arious points of the south rn h m ph re b occasi nal m ans of transport, and b th aid as halting places, of now unken islands. Thus th so thern

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throughout th world ..

b t n. And w ha n w seen that M Croll s conclu n that ccess Glacial pe od in th o e h misph re coincide w th warm r per iods th pposite h misph re, tog th r with th admiss ion of the slow modificati n of pec es, plains a multitud of facts in th distrib tio of th same and of th all ed f rms of lif all parts of the globe The li ing w ters ha fl wed during on period from th north and during another from the south, and in both case ha e reached th equat b t the tream of life has flowed w th gre ter force from th n rt than in th opposite directi n, and has conseq tly m re freel undated th so th. As th tid lea es its drift in hori zontal lines, rising highe on the shores wh re the tid rises highest, so ha e the li n wat rs l ft th ir li ng drift n our m unta n um mits, in line g ntly rising from the arctic l wlands t a great alt t d und the equ tor Th an us being thus left tranded ma be compared w th sa ge aces of man, dri n p and urv g n the m untain fastnesses f almo t ry land, which serves as a record, full of int rest to us, of th f rmer inhab tants of th urro ding lowlands.

CHAPTER XIII

GEOGRAPHICAL DISTRIBUTION *Continued*

Fresh water Productions

As LAKES and river systems are separated from each other by barriers of land it might have been thought that fresh water produc

still more formidable barr er t a y ... never have extended to distant countries But the case is exactly the reverse Not only have *many fresh water species* belonging to different classes an enormous range but allied species *prevail in a remarkable manner throughout* the world When first collecting in the fresh waters of Brazil I well remember feeling much surprise at the similarity of the fresh water insects shells &c and at the dissimilarity of the surrounding terrestrial beings compared with those of Britain

But the wide ranging power of fresh water productions can I think in most cases be explained by their having become fitted in a manner highly useful to them for short and frequent migrations from pond to pond or from stream to stream within their own countries and
follow from
sary conse
few cases of these some of the most difficult to explain are presented by fish It was formerly believed that the same fresh water species never existed on two continents distant from each other But Dr Günther has lately shown that the *Galaxias attenuatus* inhabits Tasmania New Zealand the Falkland Islands and the mainland of South America. This is a wonderful case and probably indicates dispersal from an Antarctic centre during a former warm period This case however is rendered in some degree less surprising by the species of this g nus having the power of crossing by some
open
to Ne
though separated by a distance of about 230 miles On the same continent fresh water fish often range widely and as if capriciously for in two adjoining river systems some of the species may be the same and some wholly different.

It is probable that they are occasionally transported by what may be called accidental

mainly attributed to changes
land within the recent period causing rivers to flow into each other Instances also could be given of this having occurred during floods without any change of level The wide difference of the fish on the opposite sides of most mountain ranges which are continuous and which consequently must from an early period have completely prevented the inosculation of the river systems on the two sides leads to the

for much migration Moreover Dr Günther has recently been led by several considerations to infer that with fishes the same forms have a long endurance Salt water fish can with care be slowly accustomed to live in fresh water and according to Valenciennes there is hardly a single group of which all the members are confined to fresh water so that a marine species belonging to a fresh water group might travel far along the shores of the sea, and could it is probable become adapted without much difficulty to the fresh waters of a distant land

Some species of fresh water shells have very wide range and allied species which on our theory are descended from a common parent, and must have proceeded from a single source prevail throughout the world Their distribution at first perplexed me much as their ova are not likely to be transported by birds and the ova as well as the adults are immediately killed by sea-water I could not even understand how some naturalised species have spread rapidly throughout the same country But two facts which I have observed—and many others no doubt will be discovered—throw some light on this subject When ducks suddenly emerge from a pond covered with duck weed I have twice seen these little plants

adh i h k and t l as h ppened to m aq tio fro m re

lt d shells c led n th feet, and clu g t th m so firmly th t wh ta t f tl w t ll co ld t l jarred ff tl h t

th d k s feet, in damp f t cl e to tw ty l rs and tl l tl f tim d ch or l ro m ght fly t l ast o s l n dred miles, and f bl across th to an ocean l d t any th d t t point, ld b re t l gl t pool ul t. S Charl Ly ll nf m m th t D tise has bee ca ght with an Ancyl (f l w t r h ll l k l mpet) firmly adh ri g t t and

f urr g gal can t ll

W th respect t plants, t has lo g been kn wn wh t rm ra g many f esh w t and n m rsh pec s, h b tl o co t ts and t tl most m te ocean islands. This trik gly ll tr ted according to Alpl d C d ll th se larg group f t rr trial plants, wh ch h y few aq tic m mb rs f th l tt r seem immedi t ly to ac q ire, as if conseq nce, w d rang I tl k f bl m ans f d p sal plain tl fact. I l b l m t ed th t arth occas ally adh som q antity t the feet and beaks f birds. Wad g b rds, wh ch freq t th m ddy edges f po d if d d ly flushed, w ld be th most l k ly t l m ddy f t. Bird f this rd wand r m re than those f y th and th y re occas n ally f und th m t rem t and bar n lands f th pe ocean th y w uld n t be lik ly to al ght th rfac of th sea, so that any d t n thei feet w ld n t b washed ff and wh gai g th land they w uld be re to fly to thei n t al fre h w te h u ts. I d t bel th t botanist are ware h w charged th m d f po ds is w th seed I h tried se al littl perim ts, b t w ll h re nly th most trik g case I took n

F bruary three tabl poonfuls of mud from three l ff rent po nts, be e th wat r on the edg f a littl po d th s mud wl en dried w ghed only 6¾ unce I k pt it co red up i my st dy f r six m nths, p ll g j and cou t g eacl plant as it grew tl e plants were lt r tl r 3 m

seeds f fre h wat plants to unstocked po ms and treams, tu ted t v ry d tai t po ts. Th sam ge y may ha e co e into play with the eggs f som of the sr all r fresh wat r an als.

Otl d unkn wn age c s probably have

te size as f the y ll w w t l ly a d I ot m g to H o s and tl r b rds, centi afte century ha g e n daily devo ring fish th y the take fl gl t and go to otl er w t rs, r are bl wn acr s th se n l we h e seen that seed retain the power f g rm nat wl n rejected many l urs aft ward pell ts r m th ex rem t When I saw th gre t size f th seed f th t f n wat l ly tl N l mb m and rem mbered Alpl d Cand ll s mark n tl e d trib t f th plant, I th gl t th t tl e n ns f ts l pe sal must rem n m pl cabl l ut Aud bon t tes th t he f und tl seed f tl g t south n w te lily (probably accord g to D Hook tl N l b m l t m) h rons t m h Now th b rd n t oft l flown w th ts tomach thus w ll tocked to d tant ponds, and th n g tt g a h arty m al ff sl anal gy m akes m b l e tl t t w l l h jected tl seed n a pell t a

po d tr m is first f med f ustai e

t ggl f l f b tween tl inl l t ts f tl e sam po d, h w f m h d t as th numbe n n a ll tocked pond n ll n compar w th th n be f pec m hab ting an eq al are f land tl compet t n bet een th m ll prob bly b l ss se re than between t rrestrial pecies co se j ently an

intruder from the waters of a foreign country would have a better chance of seizing on a new place than in the case of terrestrial colonists We should also remember that many fresh water productions are low in the scale of nature and we have reason to believe that such beings become modified more slowly than the high and this will give time for the migration of aquatic species We should not forget the probability of many fresh water forms having formerly ranged continuously over immense areas and then having become extinct at intermediate points But the wide distribution of fresh water plants and of the lower animals whether retaining the same identical form or in some degree modified apparently depends in main part on the wide dispersal of their seeds and eggs by animals more especially by fresh water birds which have great powers of flight and naturally travel from one piece of water to another

On the Inhabitants of Oceanic Islands

We now come to the last of the three classes of fact which I have selected as presenting the greatest amount of difficulty with respect to distribution on the view that not only all the individuals of the same species have migrated from some one area but that allied species although now inhabiting the most distant points have proceeded from a single area — the birthplace of their early progenitors I have already given my reasons for disbelieving in continental extensions within the period of existing species on so enormous a scale that all the many islands of the several oceans were thus stocked with their present terrestrial inhabitants This view removes many difficulties but it does not accord with all the facts in regard to the productions of islands In the following remarks I shall not confine myself to the mere question of dispersal but shall consider some other cases bearing on the truth of the two theories of independent creation and of descent with modification

The species of all kinds which inhabit oceanic islands are few in number compared with those on equal continental areas Alph de Candolle admits this for plants and Wollaston for insects New Zealand for instance with its lofty mountains and diversified stations extending over 780 miles of latitude together with the outlying islands of Auckland Campbell and Chatham contain altogether only 960 kinds of flowering plants if we compare this moderate number with the species which swarm over equal areas in South Western Australia or at the Cape of Good Hope we must admit that some cause independently of different physical conditions has given rise to so great a difference in number Even the uniform county of Cambridge has 847 plants and the little island of Anglesea 764 but a few ferns and a few introduced plants are included in these numbers, and the comparison in some other respects is not quite fair We have evidence that the barren island of Ascension aboriginally possessed less than half a-dozen flowering plants yet many species have now become naturalised on it, as they have in New Zealand and on every other oceanic island which can be named In St Helena there is reason to believe that the naturalised plants and animals have nearly or quite exterminated many native productions He who admits the doctrine of the creation of each separate species will have to admit that a sufficient number of the best adapted plants and animals were not created for oceanic islands for man has unintentionally stocked them far more fully and perfectly than did nature

Although in oceanic islands the species are few in number the proportion of endemic kinds (i e those found nowhere else in the world) is often extremely large If we compare for instance the number of endemic land shells in Madeira or of endemic birds in the Galapagos Archipelago with the number found on any continent and then compare the area of the island with that of the continent we shall see that this is true This fact might have been theoretically expected for as already explained species occasionally arriving after long intervals of time in the new and isolated district and having to compete with new associates would be eminently liable to modification and would often produce groups of modified descendants But it by no means follows that because in an island nearly all the species of one class are peculiar those of another class or of another section of the same class are peculiar and this difference seems to depend partly on the species which are not modified having immigrated in a body so that their mutual relations have not been much disturbed and partly on the frequent arrival of unmodified immigrants from the mother country with which the insular forms have intercrossed It should be borne in mind that the offspring of such crosses would certainly gain in vigour so that even an occasional cross would produce more effect than might have

bee anticipated I w ll gi e f w llu t ti ns of th f reg ing rem rk n th G lap go Islands there ar 6 land b rd f th se 1 (o pe h p 3) are pec l wh reas of th 11 *marr bird* nly are pec l ar an l t i obvious th t marin bird co ld arri e t th se islands m ch m re as ly and freq tl than land birds. B rm da, n th th l and wh ch lies t abo t th sam d tance from N rth Am ca as th Gal p g Islands d from So th Am ri d which has a ry pecul so l

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l eq tly is t th land Am t ar as I am inf med by M E V Harco t man E ropean and Afri an b rd are bl w to Mad ra this island is nhab ted b 99 kind f which alon is pecul ar th gh r l l rel ted t E rope n f rm and

g ther and ha becom m t ally co-adapted

t d y to modifi t ll also l be n checked by int rcrossing w th th unmodified umm g ants, ft n arri ing from th m th er co try Mad agai is inhab ted b w derf l mbe f peculiar land sh lls, wh as t pecies f se sh ll pecul to t

dred m les f pe se far m re as ly than land h lls. Th d ff rent rders f insects nhab ting Mad prese t nearly parall l cases.

Ocean island re som tim d fici t in an mals f certai wh l lasses, and th

N w Ze land is h re pok n f as an oceani l d t is in som d eed btf l wh th t l ld be so ranked t f l g ız and is t separ ted from A t al by prof undly deep se from its geol gical ch aracter and th d recti n of t m u t n a g s, th e Re W B Clark l as lately mainta ned that th s island as w ll as N w Caled n a, sh ul l be con s l red as p t ance of Au t l a. Turni g t plants, Dr Hook r has l wn that n the Galap. l th e p po ti n l n l s f th

wh t

n n m re

gro ps f mals and plants, are ge ally ac *counted f r by pposed d ff re ces n* ph cal co d t of th e la d but thi expl nati is n t a l ttl do l tf l Fac l ty of *immg t n seem t l a l een fully as im* portant as th nat re f th e co d t s.

Many remark bl l ttl facts coul l be gi n w th respect t th nh bitants f ocean c islands. F instance n ce t n land n t t anted by a ngle mamm l som f the e d m plant l b t f lly l ooked seed y t few rel t n are m re manif t th an that *l ooks serve f th t n portal of seed in the* wool f r f q ad peds. B t l ooked seed m ght be car ed t a i land by th r m ans and th plant th en becom g mod fied w ul l f rm an ndem c pec s, t ll retai ng its hooks, wh h w ld f rm useless ppend ge lik th sh lled wings u d th soldered w g-co rs f many n lar beetles. Again, lands ften po ses t ee b shc b l ging to rd rs wh ch lse l l d nly l baceo pec n w trees, as Alph de Can d ll has l wn g ally b wl te th ca se m be, confined rang s. H nce trees w ld be l ttl l k l t reach d tant oce nic land and an h b ce us plant, wh ch l ad n chance of cessf ll compet g w th th man f lly d l ped tree gro g on co ti t, m ght, wh n tablished an land gai an ad ant g th l baceous

to wh t rd t b l ged, and th first co t t into bush and th nt tree

Absence of B t h ans nd Terrestrial Mammals on O e c Isl nds

W th re pe t to th bse ce f wh l d f ammals n oceani c lands, B y St. V ce t l g g remarked th t bat achians (frogs, toads, wts) ar f und n any f the many island w th whi h th gre t oceans are t dded I l e tal pains t fy th assert n, and h f d t true, w th th cep-

tion of New Zealand, New Caledonia, the Andaman Islands, and perhaps the Solomon Islands and the Seychelles. But I have already remarked that it is doubtful whether New Zealand and New Caledonia ought to be classed as oceanic islands; and this is still more doubtful with respect to the Andaman and Solomon groups and the Seychelles. This general absence of frogs, toads, and newts on so many true oceanic islands cannot be accounted for by their physical conditions; indeed it seems that islands are peculiarly fitted for these animals; for frogs have been introduced into Madeira, the Azores, and Mauritius, and have multiplied so as to become a nuisance. But as these animals and their spawn are immediately killed (with the exception, as far as known, of one Indian species) by sea-water, there would be great difficulty in their transportal across the sea, and therefore we can see why they do not exist on strictly oceanic islands. But why, on the theory of creation, they should not have been created there, it would be very difficult to explain.

Mammals offer another and similar case. I have carefully searched the oldest voyages, and have not found a single instance, free from doubt, of a terrestrial mammal (excluding domesticated animals kept by the natives) inhabiting an island situated above 300 miles from a continent or great continental island; and many islands situated at a much less distance are equally barren. The Falkland Islands, which are inhabited by a wolf-like fox, come nearest to an exception; but this group cannot be considered as oceanic, as it lies on a bank in connection with the mainland at the distance of about 280 miles; moreover, icebergs formerly brought boulders to its western

islands will not support at least small mammals, for they occur in many parts of the world on very small islands, when lying close to a continent; and hardly an island can be named on which our smaller quadrupeds have not become naturalised and greatly multiplied. It cannot be said, on the ordinary view of creation, that there has not been time for the creation of mammals; many volcanic islands are sufficiently ancient, as shown by the stupendous degradation which they have suffered, and by their tertiary strata: there has also been time for the production of endemic species belonging to other classes; and on continents it is

known that new species of mammals appear and disappear at a quicker rate than other and lower animals. Although terrestrial mammals do not occur on oceanic islands, aerial mammals do occur on almost every island. New Zealand possesses two bats found nowhere else in the world: Norfolk Island, the Viti Archipelago, the Bonin Islands, the Caroline and Marianne Archipelagoes, and Mauritius, all possess their peculiar bats. Why, it may be asked, has the supposed creative force produced bats and no other mammals on remote islands? On my view this question can easily be answered; for no terrestrial mammal can be transported across a wide space of sea, but bats can fly across. Bats have been seen wandering by day far over the Atlantic Ocean; and two North American species either regularly or occasionally visit Bermuda, at the distance of 600 miles from the mainland. I hear from Mr. Tomes, who has specially studied this family, that many species have enormous ranges, and are found on continents and on far distant islands. Hence we have only to suppose that such wandering species have been modified in their new homes in relation to their new position, and we can understand the presence of endemic bats on oceanic islands, with the absence of all other terrestrial mammals.

inhabitants. Mr. Windsor Earl has made some striking observations on this head, since greatly extended by Mr. Wallace's admirable researches, in regard to the great Malay Archipelago, which is traversed near Celebes by a space of deep ocean, and this separates two widely distinct mammalian faunas. On either side the islands stand on a moderately shallow submarine bank, and these islands are inhabited

instance, Britain is separated by a shallow channel from Europe, and the mammals are the same on both sides; and so it is with all the islands near the shores of Australia. The West Indian Islands, on the other hand, stand on a deeply submerged bank, nearly 1000 fathoms in depth, and here we find American forms, but the species and even the genera are quite distinct. As the amount of modification which animals of all kinds undergo partly depends on

the lapse of time, and as the islands which are separated from each other or from the mainland by shallow channels, are more likely to have been continuously united within a recent period than the islands separated by deeper channels, we can understand how it is that a relation exists between the depth of the sea separating two mammalian faunas, and the degree of their affinity,—a relation which is quite inexplicable on the theory of independent acts of creation.

The foregoing statements in regard to the inhabitants of oceanic islands,—namely, the fewness of the species, with a large proportion consisting of endemic forms,—the members of certain groups, but not those of other groups in the same class, having been modified,—the absence of certain whole orders, as of batrachians and of terrestrial mammals, notwithstanding the presence of aerial bats,—the singular proportions of certain orders of plants,—herbaceous forms having been developed into trees, &c.,—seem to me to accord better with the belief in the efficiency of occasional means of transport, carried on during a long course of time, than with the belief in the former connection of all oceanic islands with the nearest continent; for on this latter view it is probable that the various classes would have immigrated more uniformly, and from the species having entered in a body their mutual relations would not have been much disturbed, and consequently they would either have not been modified, or all the species in a more equable manner.

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which still retaining the same specific form or subsequently modified, have reached their present homes. But the probability of the islands having once existed as halting places, of which not a wreck now remains, must not be overlooked. I will specify one difficult case. Almost all oceanic islands, even the most isolated and smallest, are inhabited by land shells, generally by endemic species, but sometimes by species found elsewhere,—striking instances of which have been given by Dr. A. A. Gould in relation to the Pacific. Now it is notorious that land shells are easily killed by sea-water; their eggs, at least such as I have tried, sink in it and are killed. Yet there must be some unknown, but occasionally efficient means for their transportal. Would the just hatched young sometimes adhere to the feet of birds roosting on the ground and thus get transported? It occurred to me that land ... hibernating and having a mem...

...

stand uninjured an immersion ... during seven ... on shell ... *Helix pomatia*, after having been thus treated and again hibernating was put into sea-water for twenty days, and perfectly recovered. During the length of time this shell might have been carried ... rage swiftness, ...

... the sea. Out of the hundred shells, two ... seen recovered. The presence of an operculum seems to have been of importance as ... of two ... species ... *Cyclostoma elegans* which is thus furnished ... recovered. It is remarkable, seeing how well the *Helix pomatia* resisted with me the salt water, that not one of fifty-four specimens belonging to four other species of Helix tried by Aucapitaine recovered. It is, however, not at all probable that land shells have often been thus transported; the feet of birds offer a more probable method.

On the Relations of the Inhabitants of Islands to those of the nearest Mainland

The most striking and important fact for us is the affinity of the species which inhabit islands to those of the nearest mainland, without ...

... of between 500 and 600 miles from the shores of South America. Here almost every product of the land and of the water bears the unmistakable stamp of the American continent. There are twenty-six land birds; of these twenty-one, or perhaps twenty-three are ranked as distinct species, and would commonly be assumed to have been here created; yet the close affinity of most of these birds to American species is manifest in every character in their habits, gestures, and tones of voice. So it

is with the other animals and with a large proportion of the plants as shown by Dr Hooker in his admirable *Flora* of this archipelago The naturalist looking at th se al e merican land Why should this be so? Why should the species which are supposed to have been created in the Galapagos Archipelago and nowl so nl l ed ons l ogical nature of the islands in their height or climate or in the proportions in which the several classes are associated together which closely resembles the conditions of the South American coast in fact there is a considerable dissimilarity in all these respects On the other hand there is a considerable degree of resemblance in the volcanic nature of the soil in the climate height and size of the islands between the Galapagos and Cape Verde Archipelagoes but what an entire and absolute difference in their inhabitants! The inhabitants of the Cape Verde Islands are related to those of Africa like those of the Galapagos to America Facts such as these admit of no sort of explanation on the ordinary view of independent creation whereas on the view here maintained it is obvious that the Galapagos Islands would be likely to receive colonists from America whether by occasional means of transport or (though I do not believe in this doctrine) by formerly continuous land and the Cape Verde Islands from Africa such colonists would be liable to modification —the principle of inheritance still betraying their original birthplace

Many analogous facts could be given indeed it is an almost universal rule that the endemic productions of islands are related to those of the nearest continent or of the nearest large island The exceptions are few and most of them can be explained Thus although Kerguelen Land stands nearer to Africa than to America the plants are related and that very closely as we know from Dr Hooker s account to those of America but on the view that this island has been mainly stocked by seeds brought with earth and stones on icebergs drifted by the prevailing currents, this anomaly disappears. New Zealand in its endemic planes is much more closely related to Australia, the nearest mainland than to any other region and this is what might have been expected but it is also plainly related to South America which although the next nearest continent is so enormously remote that the fact becomes an anomaly But this difficulty partially disappears on the view that New Zealand South America, and the other southern lands have been stocked in part from a nearly intermediate though distant point namely from the antarctic islands when they were clothed with vegetation during a warmer tertiary period before the commencement of the last Glacial period The affinity which though feeble I am assured by Dr Hooker is real between the flora of the south western corner of Australia and of the Cape of Good Hope is a far more remarkable case but this affinity is confined to the plants, and will no doubt some day be explained

The same law which has determined the relationship between the inhabitants of islands and the nearest mainland is sometimes displayed on a small scale but in a most interesting manner within the limits of the same archipelago Thus each separate island of the Galapagos Archipelago is tenanted and the fact is a marvellous one by many different species but these species are related to each other in a very much closer manner than to the inhabitants of the American continent or of any other quarter of the world This is what might have been expected for islands situated so near to each other would almost necessarily receive immigrants from the same original source and from each other But how is it that many of the immigrants have been differently modified though only in a small degree in islands situated within sight of each other having the same geological nature the same height climate &c ? This long appeared to me a great difficulty h t t

t c other pecies with which each has to comp te is at least as important, and generally a far more important element of succe s Now if we look to the pecies which in hal it the Galapagos Archip lago and are like wi e foun l in oti er parts of tl e world we find that tl ey diff r con ideral ly in the seve al islan ls This d ff r nc m gl t indeed have b en expected if tl e i lar ls l ad been stock l by occasional m an f tran p o t—a seed for instance of one plant hav ng b en brought to o e islan l an l tl at f anoth r plant to an other island tl ougl all proc eding from tl e am general source Hence wl en in former

times an immigrant first settled on o of th islands, or when t subseq ently spread from one t another t would undoubtedly be exposed to different conditions in the d ff rent islands for it would ha to compete w th different set of organisms plant, for instance, would find the ground best fitted f t occupied by somewhat differe t pecies in th d rent islands, and would be xposed to th attacks of somewhat diff rent nem es. If th n it varied, natural selectio w uld probably f vour different var ties in the different islands Som species, how r mi ht pread and yet retain th sam charact thro ghout th group, just as we see som pecies spread ing widel througho t co tinent and remaining the same.

The really surprising fact in this case of the Galapagos Archipelago, and in a lesser degree in som analo us cases, is that each new species after being f rmed in any n island, d d not spread quickl to th oth islands. B t the lands, though in sight of ach ther are separated b deep arms of th sea, in most cases wider than th British Chann l, and there is no reason to suppose that they ha at an form period been contin ou l united. The currents of the sea are rapid and weep between the islands, and gales of wind are extraordinarily rare so that th islands are far more ffectuall separated from each other than they ppear on a map. N rth less som of th species, both of those found in oth parts of th world and of those confined t th archipelago, are common to the se eral islands and we may i f from their present manner of distrib tion, that they have spread from one island to the others. B t w often take, I think, an rroneous view of the probability of closely allied species invading each oth t rritory hen put into free intercommunication. Undoubtedl if ne species has an ad antage er anoth t will in erv br f tim wholly or in part supplant it b t if both are equall well fitted for their own places, both will probabl hold their separat places f almost any length of tim Being familiar w th th fact that man pecies, naturalised through man agency ha spread with astonishing rapidit er wi areas, w are pt t inf that most species would thus pread b t w should remember that the species which becom naturalised in ew countries are not g nerally closely allied t the aboriginal inhab tants, but are ry distinct forms, belonging lar proportio of cases, as sh wn b Alph. d Candoll to distinct g nera. In the Gal pagos Archipelago, many en of the birds, ll ugh so w ll adapted for flying from island to island, diff on the diff rent slands, thu there are three closel -all ed pecies of mocking thrush, each confined to ts own sland. N w let us

ppose th mocking thrush of Chatham Island to be blown to Charles Island, which has ts own mocking thrush, wh ho ld t ucceed in establish g tself there We ma safel in fer that Charles Island w ll tocked witl ts own species, for annually more egg are laid and young b rds hatched, than can possibl be reared and w may inf th t the mock ng thrush peculiar to Charles Island is at least as w ll fitted f its h me as is th species peculiar to Chatham Island. S C. L ll and M Wollaston ha comm n ated to me remarkable fact bearing on this bj ct nam l that Mad ira and th adj ini t of l orto Santo possess man distinct b t representa ti e pecies of land shells, some of which li in cre ices of t n and although lar q anti ties of ton are annually tran ported from Porto Santo to Mad ira, t th latter sland has not becom colonised t th I rto Santo pecies n rth les both sland ha been colonised b E ropean land sh lls, wh h d ubt had som ad anta e r th indig species. From these consid rati ns I t l nk w need not greatl mar l t th nd mic pecies which inhab t the se eral island of th Galapagos Archipelago, not having all pread from island to island. On th sam co ti t, also, preoccupation has probabl pla ed an im portant part in checking the comm gl of th species which inhab t diff rent d tricts with n arly the sam physical cond tions. Thus, th south-east and so th-west corners of Australia ha nearly th sam ph sical conditions, and are united b co tin ous land, y t th are inhab ted b a a t n mbe of dist nct mammals, birds, and plants so t is, according t Mr B tes, with th b tte flies and other animals inhab ting th great, open, and contin us alley of th Amazons.

Th sam principl wh ch go rns th gen ral charact of th inhab tants of oceanic islands, nam l th relati n to th source wh nce colonists could ha bee most asily deri ed, t ther with their subsequ nt modi ficati n, is of th widest pplicati n thro ghout nature W see this n ry m untain summit, in very lak and marsh. F Alp species, ceptin as as far as th sam speci s ha becom wid l spread during th Glacial

epoch, are related to those of the surrounding lowlands; thus we have in South America, Alpine humming-birds, Alpine rodents, Alpine plants, &c., all strictly belonging to American forms; and it is obvious that a mountain, as it became slowly upheaved, would be colonised from the surrounding lowlands. So it is with the inhabitants of lakes and marshes, excepting in so far as great facility of transport has allowed the same forms to prevail throughout large portions of the world. We see this same principle in the character of most of the blind animals inhabiting the caves of America and of Europe. Other analogous facts could be given. It will, I believe, be found universally true, that wherever in two regions, let them be ever so distant, many closely allied or representative species occur, there will likewise be found some identical species; and wherever many closely allied species occur, there will be found many forms which some naturalists rank as distinct species, and others as mere varieties; these doubtful forms showing us the steps in the progress of modification.

The relation between the power and extent of migration in certain species, either at the present or at some former period, and the existence at remote points of the world of closely allied species, is shown in another and more general way. Mr. Gould remarked to me long ago, that in those genera of birds which range over the world, many of the species have very wide ranges. I can hardly doubt that this rule is generally true, though difficult of proof. Amongst mammals, we see it strikingly displayed in bats, and in a lesser degree in the Felidæ and Canidæ. We see the same rule in the distribution of butterflies and beetles. So it is with most of the inhabitants of fresh water, for many of the genera in the most distinct classes range over the world, and many of the species have enormous ranges. It is not meant that all, but that some of the species have very wide ranges in the genera which range very widely. Nor is it meant that the species in such genera have on an average a very wide range; for this will largely depend on how far the process of modification has gone; for instance, two varieties of the same species inhabit America and Europe, and thus the species has an immense range; but, if variation were to be carried a little further, the two varieties would be ranked as distinct species, and their range would be greatly reduced. Still less is it meant, that species which have the capacity of crossing barriers and ranging widely, as in the case of certain powerfully-winged birds, will necessarily range widely; for we should never forget that to range widely implies not only the power of crossing barriers, but the more important power of being victorious in distant lands in the struggle for life with foreign associates. But according to the view that all the species of a genus, though distributed to the most remote points of the world, are descended from a single progenitor, we ought to find, and I believe as a general rule we do find, that some at least of the species range very widely.

We should bear in mind that many genera in all classes are of ancient origin, and the species in this case will have had ample time for dispersal and subsequent modification. There is also reason to believe from geological evidence that within each great class the lower organisms change at a slower rate than the higher; consequently they will have had a better chance of ranging widely and of still retaining the same specific character. This fact, together with that of the seeds and eggs of most lowly organised forms being very minute and better fitted for distant transportal, probably accounts for a law which has long been observed, and which has lately been discussed by Alph. de Candolle in regard to plants, namely, that the lower any group of organisms stands the more widely it ranges.

The relations just discussed,—namely, lower organisms ranging more widely than the higher,—some of the species of widely ranging genera themselves ranging widely,—such facts, as Alpine, lacustrine, and marsh productions being generally related to those which live on the surrounding low lands and dry lands,—the striking relationship between the inhabitants of islands and those of the nearest mainland,—the still closer relationship of the distinct inhabitants of the islands in the same archipelago,—are inexplicable on the ordinary view of the independent creation of each species, but are explicab

the nearest

the subseque

their new homes

Summary of the last and present Chapters

In these chapters I have endeavoured to show, that if we make due allowance for our ignorance of the full effects of changes of climate and of the level of the land, which have certainly occurred within the recent period,

h r s wh h h probably oc

A I was led to this co clus n wh ch has bee arri ed t by m y t ral t d r th d gn t of gl centres of c eati n, by ar g al co sid t ns, m re e pecially from th importance f barri rs of all ki ds, and from th anal gical d tribut n f sub-g a, g a, and fam l s.

With the respect to dist n t peci s b l ging t th sam g us wh h ur th ry b p ad f m pare t soure f w mak th sam all wan s as bef re f r gn ance d rem mb th t som f rm I l f l a changed ry l wly n m pe od f t me l vi g bee thus granted to th m gr t n the difficult are far from p able th gl this case, as th t f th d d als f tl sam pec a, th y ft n gre t

As mplifying the ffect f cl m tal chang distrib t I h tt mpted to h w h w mporta t p rt th last Glac l period has pl yed wl h ffected n th eq to al reg ns, d wh cl d g tl al l rnat f th cold th n th and so th all ed th prod t f ppo t l m

pe sal f fre h t prod t

If th diffi lt b n t ns perabl in ad m tting th t in th l g cou se f t m all th ind dual f th am speci s, nd lik w se f th se f pec b l g g to th sam g s, h proceeded from som so rce th all th grand leading facts f geograpl cal d s-

te s, wl th f land w t n t nly sepa t b t in ppar tly f ming th se eral zool g cal d botan cal pro ces. W an th und rsta d th co ce trat n f re lated pecies within th sam as and how

it that und r diff re t lat tudes, f r la ice So th same ca, th nhab tant of th pla s and m ntains, f th f rests, marshes, and deserts, are l ked t th r n so m teri us a mann d re l k wise l ked t th e t ct b g wl l f r ly inhab ted th sa e continent Be ring in mind that the m t l rel t n of ganism t o gan m s of the l gl est mpo tance e can se wh y two areas ha nearly the same ph y cal co d tio s l o ld oft n be nhab t d by ve y d ff rent f rms f l fe f ccording t th l gth of t m wh ch has el psed ce th col ts t red e f th reg s, r both accord g t th n t re f the co m n cat wh ch

n t, as u

con to n e r l ss d rect co petit n w th th th bong es a l ac

fied cond t ons f l f —th re would be an al m st endless am t f o ga act n and actio —and we l uld fi l som gro ps f be greatly and som nly l gh tly mod fied—som d l ped n gre t f rce some st g scanty mbers—and thus w do find in th se ral gre t geograpl cal pro ces f th w ld

On these same prin ples we ca n l r tand as I h l ured to l w wl y oc an lands l ld ha f w d b ta ts, b t that f th se la g proport ld be

wh l gro ps f o gan ms, as b trachi ns and t re t l m mmals, l ld b abse t f m ocean l ds, wl l t th m t isol ted s-land l ld posse th r wn pecul pec f aerial mammals b ts. W can see wh in land h ld b some r l t b tween th prese ce f mammals, in m re o l ss mod fied co d t n, and th d pth f th se b tween ch island and the mai land We can clea ly se why ll th nh b tant f an a h pel g th gh pecifically dis t t th se ral l ts, h ld b l sely related to ach th and h ld lik w se be rel ted b t l ss losely t those f th are t tin t, o

other source whence immigrants might have been derived We can see why if there exists very closely allied or representative species in two areas however distant from each other some identical species will almost always there be found

As the late Edward Forbes often insisted there is a striking parallelism in the laws of life throughout time and space the laws governing the succession of forms in [illegible] s being [illegible] at the [illegible] areas [illegible] s in many [illegible] rance of [illegible] ntinuous [illegible] o the rule [illegible] that they may fairly be attributed to our not having as yet discovered in an intermediate deposit certain forms which are absent in it but which occur both above and below so in space it certainly is the general rule that the area inhabited by a single species, or by a group of species is continuous and the exceptions which are not rare [illegible] as I have attempted to show be accounted for by former migrations under different circumstances or through occasional means of transport, or by the species having become extinct in the intermediate tracts Both in time and space species and group of spe[illegible] eir points [illegible] of species, [illegible] or living [illegible] the same area [illegible]

[illegible] in looking to distant provinces throughout the world we find that species in certain classes differ little from each other whilst those in another class or only in a different section of the same order differ greatly from each other In both time and space the lowly organised members of each class generally change less than the highly organised but there are in both cases marked exceptions to the rule According to our theory these several relations throughout time and space are intelligible for whether we look to the allied forms of life which have changed during successive ages or to those which have changed after having migrated into distant quarters in both cases they are connected by the same bond of ordinary generation in both cases the laws of variation have been the same and modifications have been accumulated by the same means of natural selection

CHAPTER XIV

MUTUAL AFFINITIES OF ORGANIC BEINGS MORPHOLOGY EMBRYOLOGY RUDIMENTARY ORGANS

Class fication

FROM th most rem t period th h t ry f the world rgani being ha been f nd t resembl ach th in desce ding d grees, so that th y can be lassed in gro ps und r gro ps. This class ficat n is n t arb trary lik th gro ping of the tars con t ll t ns. The xist nce f gro p w uld ha bee f mpl r gnificance, if o gro p had bee xcl ly fitted to inhab t th land and an the th w t t feed n flesh, an th r n g tabl matt and so n b t th case is w d ly dif fere t, f t is ton u h w comm nly m m bers f th same ubgro p h diff re t hab ts. I th second and f rth cl pt s, Variat and N tural Select n, I l ttempted to sh w th t within each co ntry t is th wid ly rang g the mu h d ffused and common, that is th d minant pec s, bel g ing to th larger g nera in ach lass, wh ch ary most Th ari t es, incip t peci s, thus prod ced ultimat ly becom co rted to ew and distin t peci and these n th p inciple f inheritance, tend to prod ce tl w and d minant peci s. Conseq tl th gro p which are n w large, and wl ch g n all incl d many d minant pec es, t nd t reasing in ize I furth tt mpted t h w th t from th varying desce dants f ach speci trying t occ py as many nd as diff re t places as poss bl in th econ m f nat re, th y constantly t nd to d g n character Thi latt conclus n is ppo ted b observ th gre t d rs ty f f rm wh h, an mall area, com into th cl sest com pet tion, and by certain facts in nat ralisat n.

I att mpted also t sh w th t th re is a teady t dency n th f rm whi h re n creas ng in numb and d rging in charac t to pplant and t minat th preced g, l ss d erg nt and l ss mpro ed f rms. I req est th reader to turn t th d gram illus tratin th acti n, as f rm l xplained f these se al pri cipl and h will see th t th tabl esult is, th t th modified de scendants proceed g from prog to be come brok p into gro p bordinat to groups. I th di gram ach l tt n th p rm t l m s represent a ge a i clud

in comm n. B t tl e three g n a n u t hand h e, on th same principl mucl in comm n, and f rm a b family disti ct f m that

righ t

p

tl ree g till farth t tl right hand wl l l ged t an earl pe od. And all

from ts fam liarity does n t alw ys uffi ci tly t k us is a my t dgm nt th x plained. No d bt o ganic b gs, like all ther objects, can be classed in many w ys, e th r art ficially by ingl charact rs, o m re n tu rally by a numbe f charact rs. We kn w f r nstance, th t m ls and th l m ntal b tance can be thus arranged In thi ase tl re is of co rse no lat n t g al gi al succes- and n ca an t present be ass gned f th fall g inl gro ps. II t w th organic be gs th case d ff re t, d tl vi w abo e gi accord w th th ir n tural arrangeme t in gro p und gro p and no ther explan ti has er been tt mpted

N tu alists, as w l seen, try t ar ang th pec es, g ra, and famil es in each class, wh t is called th N tural S t m. It t wh t is m ant by this y t m Som th look at t m rely as sch m f r arrangi g to-

—th t is, by sent ce to gi th charac

ters common, for instance, to all mammals, by another those common to all carnivora, by another those common to the dog genus, and then by adding a single sentence, a full description is given of each kind of dog. The ingenuity and utility of this system are indisputable. But many naturalists think that something more is meant by the Natural System; they believe that it reveals the plan of the Creator; but unless it be specified whether order in time or space, or both, or what else is meant by the plan of the Creator, it seems to me that nothing is thus added to our knowledge. Expressions such as that famous one by Linnæus, which we often meet with in a more or less concealed form, namely, that the characters do not make the genus, but that the genus gives the characters, seem to imply that some deeper bond is included in our classifications than mere resemblance. I believe that this is the case, and that community of descent—the one known cause of close similarity in organic beings—is the bond, which though observed by various degrees of modification, is partially revealed to us by our classifications.

Let us now consider the rules followed in classification, and the difficulties which are encountered on the view that classification either gives some unknown plan of creation, or is simply a scheme for enunciating general propositions and of placing together the forms most like each other. It might have been thought (and was in ancient times thought) that those parts of the structure which determined the habits of life, and the general place of each being in the economy of nature, would be of very high importance in classification. Nothing can be more false. No one regards the external similarity of a mouse to a shrew, of a dugong to a whale, of a whale to a fish, as of any importance. These resemblances, though so intimately connected with the whole life of the being, are ranked as merely "adaptive or analogical characters;" but to the consideration of these resemblances we shall recur. It may even be given as a general rule, that the less any part of the organisation is concerned with special habits, the more important it becomes for

[illegible]

gans, [illegible] lated to the habits and food of an animal, I have always regarded as affording very clear indications of its true affinities. We are least likely in the modifications of these organs to mistake a merely adaptive for an essential character. With plants how remarkable it is that the organs of vegetation, on which their nutrition and life depend, are of little signification; whereas the organs of reproduction, with their product the seed and embryo, are of paramount importance! So again in formerly discussing certain morphological characters which are not functionally important, we have seen that they are often of the highest service in classification. This depends on their constancy throughout many allied groups; and their constancy chiefly depends on any slight deviations not having been preserved and accumulated by natural selection, which acts only on serviceable characters.

That the mere physiological importance of an organ does not determine its classificatory value, is almost proved by the fact, that in allied groups, in which the same organ, as we have every reason to suppose, has nearly the same physiological value, its classificatory value is widely different. No naturalist can have worked long at any group without being struck with this fact; and it has been fully acknowledged in the writings of almost every author. It will suffice to quote the highest authority, Robert Brown, who in speaking of certain organs in the Proteaceæ, says their generic importance, "like that of all their parts,

[illegible]

other work he says, the genera of the Connaraceæ "differ in having one or more ovaria, in the existence or absence of albumen, in the imbricate or valvular æstivation. Any one of these characters singly is frequently of more than generic importance, though here even when all taken together they appear insufficient to separate *Cnestis* from *Connarus*." To give an example amongst insects: in one great division of the Hymenoptera, the antennæ, as Westwood has remarked, are most constant in structure; in another division they differ much, and the differences are of quite subordinate value in classification; yet no one will say that the antennæ in these two divisions of the same order are of unequal physiological importance. Any number of instances could be given of the varying importance for classification of the same important organ within the same group of beings.

Again, no one will say that rudimentary or atrophied organs are of high physiological or vital importance; yet, undoubtedly, organs in this condition are often of much value in clas-

fication. No one will dispute that the rudimentary teeth in the upper jaws of young ruminants, and certain rudimentary bones of the leg, are highly serviceable in exhibiting the close affinity between ruminants and pachyderms. Robert Brown has strongly insisted on the fact that the position of the rudimentary florets is of the highest importance in the classification of the grasses.

Numerous instances could be given of characters derived from parts which must be considered of very trifling physiological importance, but which are universally admitted as highly serviceable in the definition of whole groups. For instance, whether or not there is an open passage from the nostrils to the mouth, the only character, according to Owen, which absolutely distinguishes fishes and reptiles—the inflection of the angle of the lower jaw in marsupials—the manner in which the wings of insects are folded—mere colour in certain Algæ—mere pubescence on parts of the flower in grasses—the nature of the dermal covering, as hair or feathers, in the Vertebrata. If the Ornithorhynchus had been covered with feathers instead of hair, this external and trifling character would have been considered by naturalists as an important aid in determining the degree of affinity of this strange creature to birds.

The importance, for classification, of trifling characters, mainly depends on their being correlated with many other characters of more or less importance. The value indeed of an aggregate of characters is very evident in natural history. Hence, as has often been remarked, a species may depart from its allies in several characters, both of high physiological importance, and of almost universal prevalence, and yet leave us in no doubt where it should be ranked. Hence, also, it has been found that a classification founded on any single character, however important that may be, has always failed; for no part of the organisation is invariably constant. The importance of an aggregate of characters, even when none are important, alone explains the aphorism enunciated by Linnæus, namely, that the characters do not give the genus, but the genus gives the characters; for this seems founded on the appreciation of many trifling points of resemblance, too slight to be defined. Certain plants, belonging to the Malpighiaceæ, bear perfect and degraded flowers; in the latter, as A. de Jussieu has remarked, "The greater number of the characters proper to the species, to the genus, to the family, to the class, disappear, and

"When ... m ... pounds ... ord ... yet M. Richard sagaciously saw, as Jussieu observes, that this genus should still be retained amongst the Malpighiaceæ. This case well illustrates the spirit of our classifications.

Practically, when naturalists are at work, they do not trouble themselves about the physiological value of the characters which they use in defining a group or in allocating any particular species. If they find a character nearly uniform, and common to a great number of forms, and not common to others, they use it as one of high value; if common to some lesser number, they use it as of subordinate value. This principle has been broadly confessed by some naturalists to be the true one; and by none more clearly than by that excellent botanist, Aug. St. Hilaire. If several trifling characters are always found in combination, though no apparent bond of connection can be discovered between them, especial value is set on them. As in most groups of animals, important organs, such as those for propelling the blood, or for aerating it, or those for propagating the race, are found nearly uniform, they are considered as highly serviceable in classification; but in some groups all these, the most important vital organs, are found to offer characters of quite subordinate value. Thus, as Fritz Muller has lately remarked, in the same group of crustaceans, Cypridina is furnished with a heart, whilst in two closely allied genera, namely Cypris and Cytherea, there is no such organ; one species of Cypridina has well-developed branchiæ, whilst another species is destitute of them.

We can see why characters derived from the embryo should be of equal importance with those derived from the adult, for a natural classification of course includes all ages. But it is by no means obvious, on the ordinary view, why the structure of the embryo should be more important for this purpose than that of the adult, which alone plays its full part in the economy of nature. Yet it has been strongly urged by those great naturalists, Milne Edwards and Agassiz, that embryological characters are the most important of all; and this doctrine has very generally been admitted as true. Nevertheless, their importance has sometimes been exaggerated, owing to the adaptive

characters of larvæ not having been excluded in order to show this Fritz Muller arranged by the aid of such characters alone the great class of crustaceans and the arrangement did not prove a natural one But there can be no doubt that embryonic excluding larval characters are of the highest value for classification not only with animals but with plants Thus the main divisions of flowering plants are founded on differences in the embryo —on the number and position of the cotyledons and on the mode of development of the plumule and radicle We shall immediately see why these characters possess so high a value in classification namely from the natural system being genealogical in its arrangement

Our classifications are often plainly influenced by chains of affinities Nothing can be easier than to define a number of characters common to all birds but with crustaceans any such definition has hitherto been found impossible There are crustaceans at the opposite ends of the series which have hardly a character in common yet the species at both ends from being plainly allied to others and these to others and so onwards can be recognised as unequivocally belonging to this and to no other class of the Articulata

Geographical distribution has often been used though perhaps not quite logically in classification more especially in very large groups of closely allied forms Temminck insists on the utility or even necessity of this practice in certain groups of birds and it has been followed by several entomologists and botanists

Finally with respect to the comparative value of the various groups of species such as orders sub-orders families sub families and genera, they seem to be at least at present, almost arbitrary Several of the best botanists such as Mr Bentham and others have strongly insisted on their arbitrary value Instances could be given among plants and insects of a group first ranked by practised naturalists as only a genus, and then raised to the rank of a sub family or family and this has been done, not because further research has detected important structural differences at first overlooked but because numerous allied species with slightly different grades of difference have been subsequently discovered

All the foregoing rules and aids and difficulties in classification may be explained if I do not greatly deceive myself on the view that the Natural System is founded on descent with modification —that the characters which naturalists consider as showing true affinity between any two or more species, are those which have been inherited from a common parent all true classification being genealogical —that community of descent is the hidden bond which naturalists have been unconsciously seeking, and not some unknown plan of creation or the enunciation of general propositions and the mere putting together and separating objects more or less alike

But I must explain my meaning more fully I believe that the *arrangement* of the groups within each class in due subordination and relation to each other must be strictly genealogical in order to be natural but that the *amount* of difference in the several branches or groups though allied in the same degree in blood to their common progenitor may differ greatly being due to the different degrees of modification which they have undergone and this is expressed by the forms being ranked under different genera, families sections, or orders The reader will best understand what is meant if he will take the trouble to refer to the diagram in the fourth chapter We will suppose the letters A to L [illegible] genera (A F and I) a species has transmitted modified descendants to the present day represented by the fifteen genera (a to) on the uppermost horizontal line. Now all these modified descendants from a single species are related in blood or descent in the same degree they may metaphorically be called cousins to the same millionth degree yet they differ widely and in different degrees from each other The forms descended from A now broken up into two or three families, constitute a distinct order from those descended from I also broken up into two families. Nor can the existing species descended from A be ranked in the same genus with the parent A or those from I with the parent I But the existing genus F may be supposed to have been but slightly modified and it will then rank with the parent genus F just as some few still living organisms belong to Silurian genera. So that the comparative value of the differences between these organic beings which are all related to each other in the same degree in blood has come to be widely different. Nevertheless their genealogical *arrangement* remains strictly true not only at the present time but at each successive period of descent.

All the modified descendants from A will have inherited something in common from their common parent, as will all the descendants from I; so will it be with each subordinate branch of descendants, at each successive stage. If, however, we suppose any descendant of A, or of I, to have become so much modified as to have *lost all traces of its parentage*, in this case, its place in the natural system will be lost, as seems to have occurred with some few existing organisms. All the descendants of the genus F, along its whole line of descent, are supposed to have been but little modified, and they form a single genus. But this genus, though much isolated, will still occupy its proper intermediate position. The representation of the groups, as here given in the diagram on a flat surface, is much too simple. The branches ought to have diverged *in all directions*. If the names of the groups had been simply written down in a linear series, the representation would have been still less natural; and it is notoriously not possible to represent in a series, on a flat surface, the affinities which we discover in nature amongst the beings of the same group. Thus, the Natural System is genealogical in its arrangement, like a pedigree: but the amount of modification which the different groups have undergone has to be expressed by ranking them under different so-called genera, sub-families, families, sections, orders, and classes.

It may be worth while to illustrate this view of classification, by taking the case of languages. *If we* possessed a perfect pedigree of mankind, a genealogical arrangement of the races of man would afford the best classification of the various languages now spoken throughout the world; and if all extinct languages, and all intermediate and slowly changing dialects, were to be included, such an arrangement would be the only possible one. Yet it might be that some ancient languages had altered very little and had given rise to few new languages, whilst others had altered much owing to the spreading, isolation, and state of civilisation of the several co-descended races, and had thus given rise to many new dialects and languages. The various degrees of difference between the languages of the same stock, would have to be expressed by groups subordinate to groups; but the proper or even the only possible arrangement would still be genealogical; and this would be strictly natural, as it would connect together all languages, extinct and recent, by the closest affinities, and would give the filiation and origin of each tongue.

In confirmation of this view, let us glance at the classification of varieties, which are known or believed to be descended from a single species. These are grouped under the species, with the sub-varieties under the varieties; and in some cases, as with the domestic pigeon, with several other grades of difference. Nearly the same rules are followed as in classifying species. Authors have insisted on the necessity of arranging varieties on a natural instead of an artificial system; we are cautioned, for instance, not to class two varieties of the pine-apple together, merely because their fruit, though the most important part, happens to be nearly identical; no one puts the Swedish and common turnip together, though the esculent and thickened stems are so similar. Whatever part is found to be most constant, is used in classing varieties: thus the great agriculturist Marshall says the horns are very useful for this purpose with cattle, because they are less variable than the shape or colour of the body, &c.; whereas with sheep the horns are much less serviceable, because less constant. In classing varieties, I apprehend that if we had a real pedigree, a genealogical classification would be universally preferred; and it has been attempted in some cases. For we might feel sure, whether there had been more or less modification, that the *principle of inheritance* would keep the forms together which were allied in the greatest number of points. In tumbler pigeons, though some of the sub-varieties differ in the important character of the length of the beak, yet all are kept together from having the common habit of tumbling; but the short-faced breed has nearly or quite lost this habit: nevertheless, without any thought on the subject, these tumblers are kept in the same group, because allied in blood and alike in some other respects.

With species in a state of nature, every naturalist has in fact brought descent into his classification; for he includes *in his lowest* grade, that of species, the two sexes; and how enormously these sometimes differ in the most important characters, is known to every naturalist: scarcely a single fact can be predicated in common of the adult males and hermaphrodites of certain cirripedes, and yet no one dreams of separating them. As soon as the three orchidean forms, Monachanthus, Myanthus, and Catasetum, which had previously been ranked as three distinct genera, were

known to be sometimes produced on the same plant they were immediately considered as varieties and now I have been able to show that they are the male female and hermaphrodite forms of the same species The naturalist includes as one species the various larval stages of the same individual however much they may differ from each other and from the adult as well as the so-called alternate generations of Steenstrup which can only in a technical sense be considered as the same individual He includes monsters and varieties not from their partial resemblance to the parent form but because they are descended from it

As descent has universally been used in classing together the individuals of the same species though the males and females and larvæ are sometimes extremely different and as it has been used in classing varieties which have undergone a certain and sometimes a considerable amount of modification may not this same element of descent have been unconciously used in grouping species under genera and genera under higher groups all under the so-called natural system? I believe it has been unconsciously used and thus only can I understand the several rules and guides which have been followed by our best systematists As we have no written pedigrees we are forced to trace community of descent by resemblances of any kind Therefore we chose those character which are the least likely to have been modified in relation to the conditions of life to which each species has been recently exposed Rudimentary structures on this view are as good as or even better than other parts of the organisation We care not how trifling a character may be—let it be the mere inflection of the angle of the jaw the manner in which an insect s wing is folded whether the skin be covered by hair or feathers—if it prevail throughout many and different species, especially those having very different habits of life it assume high value for we can account for its presence in so many forms with such different habits only by inheritance from a common parent We may err in this respect in regard to single points of structure but when several characters let them be ever so trifling concur throughout a large group of beings having different habits we may feel almost sure on the theory of descent that these characters have been inherited from a common ancestor and we know that such aggregated characters have especial value in classification

We can understand why a species or a group of species may depart from its allies in several of its most important characteristics and yet be safely classed with them This may be safely done and is often done as long as a sufficient number of characters let them be ever so unimportant betrays the hidden bond of community of descent Let two forms have not a single character in common yet if these extreme forms are connected together by a chain of intermediate groups we may at once infer their community of descent, and we put them all into the same class As we find organs of high physiological importance—those which serve to preserve life under the most diverse conditions of existence—are generally the most constant we attach especial value to them but if these same organs in another group or section of a group are found to differ much we at once value them less in our classification We shall presently see why embryological characters are of such high classifica

from the same parents

Analogical Resemblances —We can understand on the above views the very important distinction between real affinities and analogical or adaptive resemblances Lamarck first called attention to this subject and he has been ably followed by Macleay and others The resemblance in the shape of the body and in the fin like anterior limbs between dugongs and whales and between these two orders of mammals and fishes are analogical So is the resemblance between a mouse and a shrew mouse (Sorex) which belong to different orders and the still closer resemblance insisted on by Mr Mivart betwe n the mouse and a small mar upial animal (Antechinus) of Australia These latter resemblances may be accounted for as it seems to me by adaptation for similarly active movements through thickets and herbage together with concealment from enemies

Amongst insects there are innumerable similar instances thus Linnæus misled by external appearances actually classed an homopterous insect as a moth We ee something of the same kind even with our dome tic varietie as in the strikingly similar shape of the body in the improved breeds of the Cl in se and common pig which are descended from distinct species and in the similarly thickened stems of the

commo and specifically d tinct Swedish turnip Th resemblance between the grey hound and th raceh rse s hardly more fanci ful than the analogi which ha e been d wn by som a th s between w d ly d ff rent animals

the vi w f charact rs b ing of re l m portance fo classificat on, only n so far as they re al desc t, w can l arly u d rstand why anal gical or ad pt characters al th gh f th tm t mportance to th w lfare of the being are alm t al less t th ys tematist. r animals, b lo g g to t o most distinct lin f d scent, may ha e becom adapted to similar conditi ns, and thu h ass med a cl se xt rn l resemblance but h resemblances will n t r al—will ath te d to conceal the blood rel tionsh p W can th under tand th appare t p radox that th ry same haract rs ar analog cal when gro p comp red w th an tl b t gi e tru affinit wh th m mbe of th sam group are compared tog th th s, th h pe f th body and fi lik l mb are nly analogical wh n whal are compared with fishes, being ad ptat in both classe f r wimming th gh th w te b t bet een the se al m mb rs f th whal family the sh pe f th body and th fi lik l mb ch acters xh b ting tru affinity f r as th se parts are so arly imilar thro gl t th whol family w cann t d bt that th y h e bee inh rited from comm ancesto So t is w th fi h

Num rous cases co ld b n f trik g

nimals wh ch ar w d ly und ed n th tural y t m B t tl resembl nce s co

ppe y w f ur p m lars and ly tw m lars b lst th Th lac has thre p m lar d m lars. Th m lars also d ff m ch th t anim ls rel ti and tru t re Th adult d t t eceded by a w d ly d ff ent m lk de tit n. Any e m y f cour deny that th teeth in th case h be n ad pted f tearing flesh thro gh th tural selectio f ccessi ariat ns b t f thi b admitted in th ase t s int ll g bl to

me that t sh uld b den ed in the otl er I am glad to find that so high an uth r ty as Profe sor Flower has come to this same n clu n.

The e traord nary cases g n in a forme ch pte f wid ly diff rent fishes possess g electr c o gans,—of w dely d fferent insects possess g lum n u o gans,—a d of rel ds and ascl piad ha ing pollen masse will s- n d come nde thi same head f ana- l

ca es some f damental diff rence ti g o tl or d l pm t of the parts, and g n rally in the r matured tructure can b d tected Th d g ned is the sam b t tl means, th ugh ppearing s perfi ially to be the me re essent ally d ff rent. The pr cipl f m rly alluded to u der tl e t m f l gi l ration has probably in tl se

p g to

tances,—to nhab t, fo instance the three l ments f land and w t —we can pe hap u d rstand h w t s th t a num rical par ll l m has som t m b n bserved b twee th b g p f d tin t classes. A naturalist, struck w th a parallelism f th nature by arb trarily rai ing or inki g th al f th gro ps n sev ral classe (and all ou xpe nce sh w th t th al t on as y t rb t ary) could eas ly tend tl paral lelism e w d ang and th th septen ary q mary quart rnary and ternary clas- ficat ns ha probably arisen

Th an th and n lass f cas s n wh ch l se t rnal esemblance d es t d pe d n ad ptati n to m lar hab ts f l f b t has been gained for th sake f protect n I all d to th w d rf l mann r in wh h certain b tterfl m tat as first desc b d by Mr B t s, th and quit distinct pe This cell t observ has hown th t in som dist icts f S Am ca, wh re f instance an

Ithomia abounds in gaudy swarms another butterfly namely a Leptalis, is often found mingled in the same flock and the latter so closely resembles the Ithomia in every shade and stripe of colour and even in the shape of its wings that Mr Bates with his eyes sharpened by collecting during eleven years was though always on his guard continually deceived When the mockers and the mocked are caught and compared they are found to be very different in essential structure and to belong not only to distinct genera but often to distinct families Had this mimicry occurred n

imitates an Ithomia another mocking and mocked species belonging to the same two genera equally close in their resemblance may be found Altogether no less than ten genera are enumerated which include species that imitate other butterflies The mockers and mocked always inhabit the same region we never find an imitator living remote from the form which it imitates The mockers are almost invariably rare insects the mocked in almost every case abound in swarms In the same district in which a species of Leptalis closely imitates an Ithomia there are sometimes other Lepidoptera mimicking the same Ithomia so that in the same place species of three genera of butterflies and even a moth are found all closely resembling a butterfly belonging to a fourth genus It deserves especial notice that many of the mimicking forms of the Leptalis, as well as of the mimicked forms, can be shown by a graduated series to be merely varieties of the same species whilst others are undoubtedly distinct species But why it may be asked are certain forms treated as the mimicked and others as the mimickers? Mr Bates satisfactorily answers this question by showing that the form which is imitated keeps the usual dress of the group to which it belongs whilst the counterfeiters have changed their dress and do not resemble their nearest allies

We are next led to inquire what reason can be assigned for certain butterflies and moths so often assuming the dress of another and quite distinct form why to the perplexity of naturalists has nature condescended to the tricks of the stage? Mr Bates has, no doubt, hit on the true explanation The mocked form which always abound in numbers must habitually escape destruction to a large extent otherwise they could not exist in such swarms and a large amount of evidence has now been collected showing that they are distasteful to birds and other insect-devouring animals The mocking forms, on the other hand that inhabit the same district are comparatively rare and belong to rare groups hence they must suffer habitually from some danger for otherwise from the number of eggs laid by all butterflies, they would in three or four generations swarm over the whole country Now if a member of one of these persecuted and rare groups were to assume a dress so like that of a well-protected species that it continually deceived the practised eye of an entomologist, it would often deceive predaceous birds and insect

ecome so closely to resemble the mimicked for he found that some of the forms of Leptalis which mimic so many other butterflies varied in an extreme degree In one district several varieties occurred and of these one alone resembled to a certain extent the common Ithomia of the same district In another district there were two or three varieties one of which was much commoner than the others and this closely mocked another form of Ithomia. From facts of this nature Mr Bates concludes that the Leptalis first varies and when a variety happens to resemble in some degree any common

and insect and is consequently oftener pre-

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pelago and Africa and with some other insects. Mr Wallace has also detected one such case with birds but we have none with the larger quadrupeds The much greater frequency of imitation with insects than with other animals, is probably the consequence of their small size insects cannot defend themselves, excepting indeed the kinds furnished with a sting and I have never heard of an instance of such kinds mocking other insects though they are mocked insects cannot easily escape by flight from the

larger animals which prey on them; therefore, speaking metaphorically, they are reduced, like most weak creatures, to trickery and dissimulation.

It should be observed that the process of imitation probably never commenced between forms widely dissimilar in colour. But starting with species already somewhat like each other, the closest resemblance, if beneficial, could readily be gained by the above means; and if the imitated form was subsequently and gradually modified through any agency, the imitating form would be led along the same track, and thus be altered to almost any extent, so that it might ultimately assume an appearance or colouring wholly unlike that of the other members of the family to which it belonged. There is, however, some difficulty on this head, for it is necessary to suppose in some cases that ancient members belonging to several distinct groups, before they had diverged to their present extent, accidentally resembled a member of another and protected group in a sufficient degree to afford some slight protection; this having given the basis for the subsequent acquisition of the most perfect resemblance.

On the Nature of the Affinities connecting Organic Beings.—As the modified descendants of dominant species, belonging to the larger genera, tend to inherit the advantages which made the groups to which they belong large and their parents dominant, they are almost sure to spread widely, and to seize on more and more places in the economy of nature. The larger and more dominant groups within each class thus tend to go on increasing in size; and they consequently supplant many smaller and feebler groups. Thus we can account for the fact that all organisms, recent and extinct, are included under a few great orders, and under still fewer classes. As showing how few the higher groups are in number, and how widely they are spread throughout the world, the fact is striking that the discovery of Australia has not added an insect belonging to a new class; and that in the vegetable kingdom, as I learn from Dr. Hooker, it has added only two or three families of small size.

In the chapter on Geological Succession I attempted to show, on the principle of each group having generally diverged much in character during the long-continued process of modification, how it is that the more ancient forms of life often present characters in some degree intermediate between existing groups. As some few of the old and intermediate forms have transmitted to the present day descendants but little modified, these constitute our so-called osculant or aberrant species. The more aberrant any form is, the greater must be the number of connecting forms which have been exterminated and utterly lost. And we have some evidence of aberrant groups having suffered severely from extinction, for they are almost always represented by extremely few species; and such species as do occur are generally very distinct from each other, which again implies extinction. The genera Ornithorhynchus and Lepidosiren, for example, would not have been less aberrant had each been represented by a dozen species, instead of as at present by a single one, or by two or three. We can, I think, account for this fact only by looking at aberrant groups as forms which have been conquered by more successful competitors, with a few members still preserved under unusually favourable conditions.

Mr. Waterhouse has remarked that, when a member belonging to one group of animals exhibits an affinity to a quite distinct group, this affinity in most cases is general and not special; thus, according to Mr. Waterhouse, of all rodents, the bizcacha is most nearly related to marsupials; but in the points in which it approaches this order, its relations are general, that is, not to any one marsupial species more than to another. As these points of affinity are believed to be real and not merely adaptive, they must be due in accordance with our view to inheritance from a common progenitor. Therefore we must suppose either that all rodents, including the bizcacha, branched off from some ancient marsupial, which will naturally have been more or less intermediate in character with respect to all existing marsupials; or that both rodents and marsupials branched off from a common progenitor, and that both groups have since undergone much modification in divergent directions. On either view we must suppose that the bizcacha has retained, by inheritance, more of the characters of its ancient progenitor than have other rodents; and therefore it will not be specially related to any one existing marsupial, but indirectly to all or nearly all marsupials, from having partially retained the character of their common progenitor, or of some early member of the group. On the other hand, of all marsupials, as Mr. Waterhouse has remarked, the Phascolomys resembles most nearly, not any one species, but the general order of rodents. In this case, however, it may

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Messrs Wallace and Trimen have likewise described several equally striking cases of imitation in the Lepidoptera of the Malay Archipelago and Africa and with some other insects Mr Wallace has also detected one such case with birds but we have none with the larger quadrupeds The much greater frequency of imitation with insects than with other animals is probably the consequence of their small size insects cannot defend themselves excepting indeed the kind furnished with a sting and I have never heard of an [illegible]

perfected, gen al gical m t ar angem nt th the grades of d ff rence e pressed l y the t rms ge ra, families, ord rs, & w can un derstand th rules which we are com pelled to follow m our lassifi tion. We an und rstand hy w al e certain resemblances far more than oth rs wl y w se rud m nt rs an l useless organs, or oth rs of trifli g physiologi al mportance why m finding th rel tions bet en one group and anoth r we mmarily reject analogical or ad pt e cl aract rs, and yet use these same charact rs w th tl l m ts of th sam gro p. W can learl see l w t that all h m and e tin t forms can be grou ped togeth r w thin a f gre t classe and l the se ral m mbers of each la re con

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of re tion, e may hope t make sure b t slow progress.

Prof ssor Haeckel in his *Generelle Morphologie* and in oth w ks, has recently bro gl t his gre t kn ledg and abil ties to bear on hat h calls phylogeny o the lm of descent of all organ beings. In drawing p tl se ral se se h t usts chiefly to mbryolog al charact rs, b t rece aid from h m l vous and rud m tary organs, as w ll as from th ucessi periods t which the arious forms of lif are belie ed t ha e first ppeared in ur geological formations. H has thus boldl mad great beginning, and sh n l w classificat will in th f t re be tre ted

M phology

W ha seen that th m mbers of th sam lass, ind pe d ntl f th ir hab t f l f resembl ach oth th g n ral plan of th rganisatio Th resemblance is ft n expressed b th t rm ty of t pe o by sa ing that tl se ral part and organs in the diff re t pe es f the lass are l m l gous. The h le bject is ncl ded und th ge ral t rr f M rph logy Th is of the most l re t g d partm nt f natural history and ma almost be said t be t ry so l Wh t an be m re uri us than th t tl hand f man, f rmed for gra pin g that f *mol f digging th l g f th l rse th* pad ll f tl porpose and the wing of the bat, sh ld all be con tructed n tl sam patt rn and should nclud sim lar bo s, th sam relat ve position H w curiou ll is, to gi e a bordinat tl ough triking instance th t tl h nd f et of the kangaroo, wl icl are so ll

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eatin band coots,—ar u l ose ... ... arsupials,—should all be on

the same skin, so that tl ey appear as toe furn isl ed w th two claws. N tw th tand ng this similarity of patt n, it s b us that tl e l ind feet f these se eral an mals are used for as w d ly different p rposes as t p ssibl t conce e Tl e ase s rendered all tl e re triking by the Am rican opossums, wl ich f llow n arl the same hab ts of l f as some of th ir Au tral an relati es, ha ing f et constru ted n tl e ord nary plan l rofessor Fl w from wh m these tatem nts are tak n, remarks in conclusion We ma call this con f t to t pe w thout getting mu h n arer

Geoffroy St. Hilaire l as trongly n ted on th h gl importance of rel t e p t on or connectio in hom l o parts the may diff to almost an t nt i f rm and size and y t remain con ct d togetl r tl sam e in ariabl rd r We n r find for tai e th bon of th rm and fore-arm r of tl e th gh and leg tran posed H ce tl sam names can be gi en t tl l m logo bo m w d ly d ff rent animals. W see tl e san great l w the constr t on of th m uths of

organs, serving f r u l w d ly d ff r t purposes, are f rmed b fin t l n m ro s modificat ns of an upper l p, mand bles, and t o pairs f max llae Tl sa l w g r tl con tru t n f tl n ths d l mb f s taceans. So t w tl th fl rs f plant

N th g can b m re l peless tl an t t t mpt t plain th is m larity f patte n m mbers of tl e sam class, by t l t o by tl doctr f fi al ses. Th l pel ssi ss of th H mpt has been pressly adm tted by Ow n n l m st t re ting rk on the N

be strongly suspected that the resemblance is only analogical owing to the Phascolomys having become adapted to habits like those of a rodent The elder De Candolle has made nearly similar observations on the general nature of the affinities of distinct families of plants

On the principle of the multiplication and gradual divergence in character of the species descended from a common progenitor together with their retention by inheritance of some characters in common we can understand the excessively complex and radiating

now broken up by extinction into distinct groups and sub groups will have transmitted some of its characters modified in various ways and degrees to all the species and they will consequently be related to each other by circuitous lines of affinity of various lengths (as may be seen in the diagrams so often referred to) mounting up through many predecessors As it is difficult to show the blood relationship between the numerous kindred of any ancient and noble family even by the aid of a genealogical tree and almost impossible to do so without this aid we can understand the extraordinary difficulty which naturalists have experienced in describing without the aid of a diagram the various affinities which they perceive between the many living and extinct members of the same great natural class

Extinction as we have seen in the fourth chapter has played an important part in defining and widening the intervals between the several groups in each class We may thus account for the distinctness of whole classes from each other—for instance of birds from all other vertebrate animals—by the belief that many ancient forms of life have been utterly lost through which the early progenitors of birds were formerly connected with the early progenitors of the other and at that time less differentiated vertebrate classes There has been much less extinction of the forms of life which once connected fishes with batrachians There has been still less within some whole classes, for instance the Crustacea, for here the most wonderfully diverse forms are still linked together by a long and only partially broken chain of affinities Extinction has only defined the groups it has by no means made them for if every form which has ever lived on this earth were suddenly to reappear though it would be quite impossible to give definitions by which each group could be distinguished still a natural classification or at least a natural arrangement would be possible We shall see this by turning to the diagram the letters, A to L may represent eleven Silurian genera, some of which have produced large groups of modified descendants with every link in each branch and sub branch still alive and the links not greater than those between existing varieties In this case it would be quite impossible to give definitions by which the several members of the several groups could be distinguished from their more immediate parents and descendants Yet the arrangement in the diagram would still hold good and would be natural for on the principle of inheritance all the forms descended for instance from A would have something in common In a tree we can distinguish this or that branch though at the actual fork the two unite and blend together We could not as I have said define the several groups but we could pick out types or forms, representing most of the characters of each group whether large or small and thus give a general idea of the value of the differences between them This is what we should be driven to if we were ever to succeed in collecting all the forms in any one class which have lived throughout all time and space Assuredly we shall never succeed in making so perfect a collection nevertheless, in certain classes we are tending towards this end and Milne Edwards has lately insisted in an able paper on the high importance of looking to types whether or not we can separate and define the groups to which such types belong

Finally we have seen that natural selection which follows from the struggle for existence and which almost inevitably leads to extinction and divergence of character in the descendants from any one parent species explains that great and universal feature in the affinities of all organic beings namely their subordination in group under group We use the element of descent in classing the individuals of both sexes and of all ages under one species, although they may have but few characters in common we use descent in classing acknowledged varieties however different they may be from their parents and I believe that this element of descent is the hidden bond of connection which naturalists have sought under the term of the Natural System On this idea of the natural system being in so far as it has been

brata probably possessed many v rtebræ the unkn wn prog nit r f th Art culata, many segm ts and th unknown p ogenit r f flowering plants, many l es arranged in ne or more sp res. W ha e also f rm ly seen that parts man times repeated are min ntly liable t arr not nly in n mber b t i form C nseq tly such parts, be g lread p esent in consid rabl umbers, and being highly ariable, w ld naturally aff d th mat rials for adaptati t th most diff t purposes t the w ld g n rally r tain, thr gh th *force of inheritance*, plain tr ces f their original or f dam tal resemblance. They would retain this resemblance all th m re, as th ariations, which aff rded th basis for their subseq t modificati thro gh natural selecti n, w ld t d from th first t be similar the parts being t an arly tag f gro th alike and being bjected t nearly th sam co d t ns. S ch parts, wh the m re or less modified, unless th ir comm n or gin becam wh lly obsc red, w uld be serially h m l s.

In th great class of m ll scs, th ugh th parts in disti ct species can be h wn to be homologous, ly f w serial h m l ries, s ch as th al es f chitons, can be dicated that is, w are seld m nabled t say that part is h m l g us with an ther part in th sam individual. And w can u d rstand this fact f in m llusc, n in the l west members f th lass, w d n t find n arly so m ch indefinit repetition f any part as w find in th th great classes f th animal and getabl kingd ms.

B t m rph l gy is a m ch more complex subject than t t first ppears, as has lately bee w ll sh wn in remarkabl pape by Mr E. Ra Lankester wh has drawn an im

distinct animals ing to th ir descent from a comm pro nito with subseq ent modificatio *homogenous* and th resemblances which cannot th be accounted f h proposes to call *homoplastic* F instance h belie es that th hearts f b ds and mammals are as whole hom g us,—that is, ha been de ri ed *from* comm n prog nito b t that the four ca ties f th heart in the tw lasses are homoplastic,—that is, ha been independ tl d loped. Mr Lankester also add ces the lose resemblance f the parts n th right and left des of tl e body and in the successi e f h m ndivid al animal and

mperfect mann r as anal gou mou ... o resemblances. The r formati n may be at trib ted in part to distinct rganisms, or t dist f th same organism, h n

Naturalists frequently peak o ... f rmed f metam rph sed ertebræ th j w of crabs as m tam rphosed *legs* the tam n and pistils in fl w rs as m tamorphosed l a b t t w uld in m t case be m re correct as Professo Huxley has remarked, to peak f both skull and rtebræ j s and legs, &c. as ha ing been m tam rph sed not on from tl e oth as they n w xist, b t from some com *mon and mpl r l m nt.* Most n turalists, h w use such langu g only in a m ta ph rical sense th y are far from m aning tl t

v rted in ... ppearance of this having occurred tl t naturalists can hardl a d mpl y g lan gu g ng this plain gnificati n. According to th w he maintained, such l n guage may be used lite ally and the w d rful fact of th j ws, f r instance of crab retai ing num rous characters wh ch they prob bl w uld ha retained through inh ritance f th y had really been m tamorphosed from tru th gh trem ly *simple* l gs, is n part explained.

Development and Embryology

This is o f th most important subjects in th whol round f hi tory Th metam rphoses f insects, with wh ch ty o familiar are g rally effected abruptly by a few stages but th transf rmations are in reality num rous and gradual, th gh concealed. A certain ph m rous nsect (Chloeo) during dev lopm nt, mo lts, as sh wn by Sir J Lubbock, abo tw ty times and each tim und rgoes certain amount of chang and in this case w see th act of m tam rph osis perf rmed in a primary and grad l m n

ture of Limbs On the ordinary view of the independent creation of each being we can only say that so it is —that it has pleased the Creator to construct all the animals and plants in each great class on a uniform plan but this is not a scientific explanation

The explanation is to a l... ...iple ...sive ...ing ... some way to the modified form but often affecting by correlation other parts of the organisation In changes of this nature there will be little or no tendency to alter the original pattern or to transpose the parts The bones of a limb might be shortened and flattened to any extent, becoming at the same time enveloped in thick membrane so as to serve as a fin or a webbed hand might have all its bones or certain bones lengthened to any extent, with the membrane connecting them increased so as to serve as a wing yet all these modifications would not tend to alter the framework of the bones or the relative connection of the parts If we suppose that an early progenitor—the archetype as it may be called —of all mammals birds and reptiles had its limbs constructed on the existing general pattern for whatever purpose they served we can at once perceive the plain signification of the homologous construction of the limbs throughout the class So with the mouths of insects we have only to suppose that their common progenitor had an upper lip mandibles and two pairs of maxillæ these parts being perhaps very simple in form and then natural selection will account for the infinite diversity in the structure and functions of the mouths of insects. Nevertheless it is conceivable that the general pattern of an organ might become so much obscured as to be finally lost by the reduction and ultimately by the complete abortion of certain parts, ...

... ...as ... ...tain suctorial crustaceans the general pattern seems thus to have become partially obscured

There is another and equally curious branch of our subject namely *serial homologies* or the comparison of the different parts or organs in the same individual and not of the same parts or organs in different members of the same class Most physiologists believe that the bones of the skull are homologous—that is, correspond in number and in relative connexion—with the elemental parts of a certain number of vertebræ The anterior and posterior limbs in all the higher vertebrate classes are plainly homologous So it is with the wonderfully complex jaws and legs of crustaceans. It is familiar to almo... ...n a... ...als, ...ate ...ey ... metamorphosed leaves arranged in a ...pire In monstrous plants, we often get direct evidence of the possibility of one organ being transformed into another and we can actually see during the early or embryonic stages of development in flowers, as well as in crustaceans and many other animals, that organs which when mature become extremely different are at first exactly alike

How inexplicable are the cases of serial homologies on the ordinary view of creation! Why should the brain be enclosed in a box composed of such numerous and such extraordinarily shaped pieces of bone apparently representing vertebræ As Owen has remarked the benefit derived from the yielding of the separat... ...

... ...a similar bones have been created to form the wing and the leg of a bat used as they are for such totally different purposes, namely flying and walking? Why should one crustacean which has an extremely complex mouth formed of many parts consequently always have fewer legs or conversely those with many legs have simpler mouths Why ...uld the sepals petal stamens and pistil in each flower though fitted for such distinct purposes, be all constructed on the same pattern?

On the theory of natural selection we can to a certain extent answer these questions. We need not here consider how the bodies of some animals first became divided into a series of segments or how they became divided into right and left sides with corresponding organs, for such questions are almost beyond investigation It is, however probable that some serial structures are the result of cells multiplying by division entailing the multiplication of the parts dev...ed ...

... ...or ... ...specialised forms therefore the unknown progenitor of the Verte

and wate We ha e n m re reason to be b m h rel ti n, than w h to believ th t th s milar bones th hand of man, wing of a b t, and fi f porpoise, are rel ted to similar conditio s f l f N m upposes that the tripe n the wh lp f l the spots th y g blackb rd, are f any use t thes m ls.

the lar to ts co diti ns of lif i just as pe fect and as be tif l as i the ad lt animal. In h w impo tant mann r thi l as acted, l as ece tly bee w ll sho n by S r J L bbock in h m ks tl cl e m l rity f the l m of som nsects b l g g t y d ff nt rd rs, and n tl d ss m lar ty f th larvæ of th nsects within th sam rde according

same larv has d n g o stag t search f r food, and d ring an the tag has to s arch f a place f ttachm t. Cases can e n be g l the larvæ f allied pecies, gro ps f peci diff n g m re from ach th than d th adults In m t cases, h r the larvæ, th gh acti st ll bey m re less l sely th l w f comm n mbry nic esem blance. Cirripedes aff rd a good in tance f thi th llustri us Cu did n t per ce that a barnacl was cr tacean b t a glance at the lar show thi n an nmi tak abl mann So agai th tw mai di m ns f cirriped s, th pedun lated and sessil th gh diff ri g w d ly t rnal ppear ance h l æ n all th tag barely

poss bl t d fin cl arly wh t m ant by th ganisati be g high l w B t n probably all disp t th t th butt rfly is h gh than th cat rp llar In some ases, h th mat re animal must b consid red as lo th scale than th larva, as w th certai paras tic crustaceans. T f ce again to cirriped th lar æ n th first tag h three pai f locom ti gans, simpl singl ye, and probosci rmed m th with

which tl ey feed largely f r they increase much in si e In the seco d stage, answeri g to tl e chrysalis st ge f butte flies, they l ave x pairs f bea tifully con tructed natatory legs, a n f magnificent compo nd eyes, and x t

th y again tain a
but th y have no antennæ, and th r tw eye are n w reconve ted i to a minut gl simpl ye-spot. In th s last and compl t riped m y b cons dered as tl r

a th larvæ becom
rod t h ng th ord nary tructure and to what I ha called complem i tal mal s d in th l tte th d el pm nt has ass redly been retrograde f th mal is a mere sack, which li es f r a sh t time a d i destitut of mo th tomach, and ry othe organ f portance, excepting those fo reprodu tion

W are so m ch accustomed to see a diff e e in stru ture b tween tl embryo and tl e adult, that we ar tempted t look at thi d f f rence as in some necessary manner conting t n growth B t th re s no r ason why f instance th wi g of a b t, the fin f a po poise, sh uld n t h been sk tched out w th all th r p rts in prope propo ti n, as soon a any part becam bl in som wh l gro p f animals and in ce tain m mb rs of th gro p thus th case, d the emb y doe n t t any period d ff widely from tl ad lt thus Ow n has remarked n regard to cuttle-fish Th e m tam rphos the cephalo podic charact manifested l ng b f re th parts f the mbry are compl ted Land sh ll and fre h w t ustace ns are born ha g th prope f ms, wh l t th n arı m mb rs f tl same t o gre t classes pass thro gh cons d abl d ft n great l anges during th d l pm nt. Sp d rs, again, barely und g any m tam rphosis. The lar æ f m t insects pass thr gh worm l k tag wh th th y re act and ad pted to di er

ner Many insects and especially certain crustaceans show us what wonderful changes of structure can be effected during development Such changes however reach their acme in the so-called alternate generations of

a submarine rock *should produce first by* budding and then by transverse division a host of huge floating jelly fishes and that these should produce egg from which are hatched swimming animalcules which attach themselves *to rocks and become developed* into branching coralline and so on in an end less cycle The belief in the essential identity of the process of alternate generation and of ordinary metamorphosis has been greatly *strengthened by* Wagners discovery of the larva or maggot of a fly namely the Cecid omyia producing asexually other larvæ and these others which finally are developed into mature males and females propagating their kind *in the ordinary manner by* eggs

It may be worth notice that when Wagners remarkable discovery was first announced I was asked how was it possible to account for the larvæ of this fly having acquired the power of a sexual reproduction A long as the case remained unique no answer could be given But already Grimm has shown that another fly a Chironomus reproduces itself in nearly the same manner and he believes that this

this ca to a certain extent unites that of the Cecidomyia with the parthenogenesis of the *Coccidæ —the term partheno enesis imply* ing that the mature females of the Coccidæ are capable of producing fertile eggs without the concourse of the males Certain animals belonging to several classes are now known to *have the power of ordinary reproduction at an* unusually early age and we have only to ac

stage viz that of the pupa—and we can perhaps account for the marvellous case of the Cecidomyia

It has already been stated that various parts in the same individual which are exactly alike during an early embryonic period become widely different and serve for widely different purpose in the adult state So again it has been shown that generally the embryos of the most distinct species belonging to the same class are closely similar but become when *fully developed widely dissimilar* A better proof of this latter fact cannot be given than the statement by von Baer that The embryos of mammalia of birds lizard and snakes, probably also of chelonia are in their earliest *states exceedingly* like one another both as a whole and in the mode of development of their parts so much so in fact that we can often distinguish the embryos only by their size In my possession are two little embryos in spirit, *whose names I have omitted to attach* and at present I am quite unable to say to what class they belong They may be lizards or small birds or very young mammalia, so complete is the similarity in the mode of formation of the *head and trunk in these animals* The extremities however are still absent in these embryos But even if they had existed in the earliest stage of their development we should learn nothing for the feet of lizards and mammal *the wings and feet of birds no less than* the hands and feet of man all arise from the same fundamental form The larvæ of most crustaceans at corresponding stages of de

law of embryonic resemblance occasionally lasts till a rather late age thus birds of the same genus and of allied genera often *resemble each other in their immature plumage* as we see in the spotted feathers in the young of the thrush group In the cat tribe most of the species when adult are striped or spotted in lines and stripes or spots can be plainly distinguished in the whelp of the lion and the puma We occasionally though rarely see something of the same kind in plants thus the *first* leaves of the ulex or furze and the first leaves of the phyllodineous acacias are pinnate or divided like the ordinary leaves of the leguminosæ

direct relation to their conditions of existence

hatched in a nest and in the spawn of a frog

As we ha co clusi e evidence that th breeds of th p geon are d scended from a single wild peci s, I compared the y ung w l h rs afte bei g h tched I

mo ... feet and l ngth f l g th w ld pare t pe- cies, in po l rs, fantails, ru ts, barbs, drag ns,

l

in oth r charact s, ... ha e bee ranked as d tin t g n ra d f und in a tat of nat re B t wl n the n tling b rd of th se se al breeds re placed in a row though most f th m co ld j t be d tin gu hed, th proporti nal diff re ce in th bo specified points were incomparably less than in th full grown birds. Some charact stic poi ts f diff rence—f r nstance th t f

th adult tat

Th se facts are explained by th abo e tw principles. Fanci rs select th d gs, h rses, p geons, &c., f r breed ng, wh n n arly grown up th y are diff re t wh th th d sired q alities are acquired arh l t in lif if th full gro n animal possesses th m And the

d not g rally ppear t a ry ly period of lif and are nh ted t corre po di g not arly period B t th case f the sh t faced t mbl which wh n tw l h rs ld possessed t j rope charact rs, p th t th t th uni rsal rul f h th char act ristic diff re ce m t th h ppeared t an arh period than al, f t so, th diff re ce m t h bee inh rited, t I correspo di g, b t t an arh age.

N w l t pply th se tw pri ciples t peci tal of ture. Let us tak gro p of birds, descended from som anci t f rm and modified thro gh nat ral selecti n f dif f re t hab ts. Th n, from th man slight suc cessi ari ti ns ha in superv ed in the se al peces t n t ly a, and ha g bee nh rited I corresponding age, th

prog nito may h ve become thro gh a l g course f modificati ad pted in o e de- scendant t act as hands, i another as paddl s, in an ther as wi gs b t on th abo tw principles the f re limbs w ll not have been m ch modified the mbry s of th se se ral form altho gh n ach form the f re-limb w ll differ gre tly in the ad lt tat Whate e in flu ce lo g-cont ued use or di use m y h e had n modif ng th limbs or other part of any pecies, this w ll chi fly sol ly have af fected t when n arly m ture when t was compelled to use its full pow rs to gain ts own li g and th effects thu produced will ha l

m y h e pers ned at a ery early period of life th t ps may h been inherited at an arh r age than th t t which th y first oc urred In th s of these cases, th young or embry w ll closely resemble th mature par t f rm, w h e see with th short faced tumbl And th is th rule f d elopment n certain wl l gro ps, in certain s b-gro p alo as w th ttle-fish, land shells, fresh w ter cru taceans, p d rs, and som m mb rs of th gre t lass f nsects. W th respect t the final se f th y ung in ch group n t passing th ro gh any m tamorphosis, we an see that this w ld f ll w from th f ll w g cont g cies am ly from th y u g h vi g t pro de t ry earl age f th ir wn wants, and fro th ir f ll wi the sam hab- t of lif w th th ir parents f in this case it w uld b nd pensabl f r th ex t nce th t th y sh ld be modified th same mann as th pare ts. Again, w th respect t th singu lar fact th t many t estrial and fresh w t animals d n t u d go any m tam rph sis, whilst marin m mbers of th same gro p

in that of Aphis if we look to the admirable drawings of the development of this insect by Professor Huxley we see hardly any trace of the vermiform stage

Sometimes it is only the earlier developmental stages which fail Thus Fritz Müller has made the remarkable discovery that certain shrimp-like crustaceans (allied to Penæus) first appear under the simple nauplius-form and after passing through two or more zoea stages and then through the mysis stage finally acquire their mature structure now in the whole great malacostracan order to which these crustaceans belong no other m n ber is r the oeas s be

t that if there had been no suppression of development, all these crustaceans would have appeared as nauplii

How then can we explain these several facts in embryology —namely the very general though not universal difference in structure between the embryo and the adult —the various parts in the same individual embryo which ultimately become very unlike and serve for diverse purpose being at an early period of growth alike —the common but not invariable resemblance between the embryos or larvæ of the most distinct species in the same class —the embryo often retaining whilst within the egg or womb structures which are of no service to it, either at that or at a later period of life on the other hand larvæ which have to provide for their own wants being perfectly adapted to the surrounding conditions —and lastly the fact of certain larvæ standing higher in the scale of organisation than the mature animal into which they are developed? I believe that all these facts can be explained as follows

It is commonly assumed perhaps from monstrosities affecting the embryo at a very early period that slight variations or individual differences necessarily appear at an equally early period We have little evidence on this head but what we have certainly points the other way for it is notorious that breeders of cattle horses and various fancy animals, cannot positively tell until some time after birth what will be the merits or demerits of their young animals We see this plainly in our own children we cannot tell whether a child will be tall or short, or what its precise features will be The question is not at what period of life each variation may have been caused but at what period the effects are displayed The cause may have acted and I believe often has acted on one or both parents before the act of generation It deserves notice that it is of no importance to a very young animal as long as it remains in its mother's womb or in the egg or as long as it is nourished and protected by its parent whether most of its characters are acquired a little earlier or later in life It would not signify for instance to a bird which obtained its food by having a much-curved beak whether or not whilst young it possessed a beak of this shape as long as it was fed by its parents.

I have stated in the first chapter that at whatever age a variation first appears in the parent it tends to reappear at a corresponding age in the offspring Certain variations can only appear at corresponding ages for instance peculiarities in the caterpillar cocoon or imago states of the silk moth

reappear at a corresponding age in the offspring and parent I am far from meaning that this is invariably the case and I could give several exceptional cases of variations (taking the word in the largest sense) which have supervened at an earlier age in the child than in the parent

T

ing not early period explain as I believe all the above specified leading facts in embryology But first let us look to a few analogous cases in our domestic varieties Some authors who have written on dog maintain that the greyhound and bulldog though so different are really closely allied varieties descended from the same wild stock hence I was curious to see how far their puppies differed from each other I was told by breeders that they differed just as much as their parents, and this, judging by the eye seemed almost to be

was told that the foals of cart and race horses—breeds which have been almost wholly formed by selection under domestication—differed as much as the full grown animals but having had careful measurements made of the dams and of three-days-old colts of race and heavy cart horses, I find that this is by no means the case

conditi n, if th y pass thro gh cl sely similar mbry nic tages, w m y feel ass red that th y all are desce ded from e parent-f rm, and are th ref re cl sely related Th s, com munit mbry nic tru t ere eal commu nity of desce t b t diss m larity n mbry nic d lopm t doe n t pro d scommunity f desce t, fo in e f tw gro ps th d el p-m tal stages m y ha been pp ssed o m y h bee so greatly modified thro gh ad ptati to ew hab ts f life, as to be h recognisable. E in gro ps, n which

f instance th u p s,

so lik sh ll fish, are t ce kn wn by th larvæ to bel g to the great class f crustaceans. As th mbryo ft n show u m re less plainly th tru ture f th less mod ified and anci t prog nit f th gro p, we can see why ancie t and e tin t forms so oft n resemble th ir ad lt tat the mbry of xisti g speci f the sam lass Agassiz be-li es this to b uni rsal law f nat re and

oblite ted th by ccess variati ns ha ing pe ed t ry arly period f gro th, by ch an t h g been nh rited t an arli ag than that at which they first ppeared It h ld also b born n mind th t th l w m y b tr b t y t, ow ng to th geological record n t t ndin far gh back in tim may remain f lo g period I capabl f d m nstrati n. The law w ll t tr ctly h ld good in those ase in wh ch an anci t f m becam ad pted in ts larvæ tat to som pecial h of lif and t ansm tted th sam larval tat to wh l gro p f d sce d ts f ch lar ll n t sembl any tull m re an t f rm ts ad lt tat

Th s, as t seem t me, th l ad g facts in mbry l gy wh ch are seco d to n m portance ar xplained th pri cipl f ari tions th many desce dants from som anci t prog nit h g ppeared t f rs arly period f l f and h b n h rited t corresp d g period. Embryol gy rise gre tly t re t wh w look t th mbry as pi t re, m re l ss bsc red, f th prog nito th ts adult r larval t te f all th m mbers of the sam gre t lass.

Rudimentary Atrophied and Aborted Organs

Organs or parts in this strange co d ti n b ring the plain tamp f inutility are ex trem ly comm n, or ev n gene al, througl out nature It w uld be impossibl to name ne of the high r animals n which some pa t or tl er i t n a rudim ntary co ditio In tl e m m

used f r fligl t. Wh t can be m re i s tl an th presence of teeth in fœtal wl al s, which wh n grown h a n t a tooth n tl r l ad o th teeth which ne u t thro gh the g ms, in th ppe j w s f unborn cal s

R dim ntary rgans plainly declare the r gi and mean g n an us wa s. Th re are beetl s bel gi g to cl sely all ed pecies, o e t th sam id ntical pec s, whi cl l o eithe full sized and pe fect w s, or mere rudiments f m mbran which n t rarely l unde wing-co rs firmly soldered t getl er and in th se cases t is imposs bl to do bt th t th rudim nts rep sent w gs. Rud m tary g ns som t m retain th i poten tiality th occasi nall occ w th tl mam mæ f mal mammals, whi h h bee kn wn to become w ll de l ped and t secret milk So again in th dd rs in th g us Bos, there are n rmally f ur de el ped and two rudi m tary te ts b t th l tt u d m tic cow som t mes become w ll de l ped and y ld milk. In regard to plants th petals are som tim rud m tary and som tim w ll d l ped in th ndi d als f the sam pe ci s. I ce tain plants ha ng separated se es K lre te f und th t by cross ng a peci s, n which th mal fl w in l ded a dim nt f a p til w th an h m phrodit peci s, hav g f co se a well-d l ped p til, th rud ment n th hybrid off pri g was m cl increased in siz and th l arly h w that th rud m n tary and perfect pistil are essentially alike in nature. An animal m y possess vari us part in perfect tat and y t th y may m se be rudim tary f th y are useless thus th tadpole f th comm n sal mand w te wt, as Mr G H Lew remarks, has g lls, and passes ts xist ce n the w te b t th *Sal mand at a*, which li es h gh up am g th m tains, bri g f rth ts y un

through any larval stage for it is not probable that places well adapted for both the larval and mature stages under such new and greatly changed habits of life would commonly be found unoccupied or ill occupied by other organisms In this case the gradual acquirement at an earlier and earlier age of the adult structure would be favoured by natural selection and all traces of former metamorphoses would finally be lost

If on the other hand it profited the young of an animal to follow habits of life slightly different from those of the parent form and consequently to be constructed on a slightly different plan or if it profited a larva already different from its parent to change still further then on the principle of inheritance at corresponding ages the young or the larva might be rendered by natural selection more and more different from their parents to any conceivable extent Differences in the larva might also become correlated with successive stages of its development so that the larva in the first stage might come to differ greatly from the larva in the second stage as is the case with many animals The adult might also become fitted for sites or habits in which organs of locomotion or of the senses &c would be useless and in this case the metamorphosis would be retrograde

From the remarks just made we can see how by changes of structure in the young in conformity with changed habits of life together with inheritance at corresponding ages animals might come to pass through stages of development perfectly distinct from the primordial condition of their adult progenitors Most of our best authorities are now convinced that the various larval and pupal stages of insects have thus been acquired through adaptation and not through inheritance from some ancient form The curious case of Sitaris—a beetle which passes through certain unusual stages of development—will illustrate how this might occur The first larval form is described by M Fabre as an active minute insect furnished with six legs two long antennæ and four eyes. These larvæ are hatched in the nests of bees and when the male bees emerge from their burrows in the spring which they do before the females the larvæ spring on them and afterwards crawl on to the females whilst paired with the males As soon as the female bee deposits her eggs on the surface of the honey stored in the cells the larvæ of the Sitaris leap on the eggs and devour them Afterwards they undergo a complete change their eyes disappear their legs and antennæ become rudimentary and they feed on honey so that they now more closely resemble the ordinary larvæ of insects ultimately they undergo a further transformation and finally emerge as the perfect beetle Now if an insect, undergoing transformations like those of the Sitaris were to become the progenitor of a whole new class of insects the course of development of the new class would be widely different from that of our existing insects and the first larval stage certainly would not represent the former condition of any adult and ancient form

On the other hand it is highly probable that with many animals the embryonic or larval stages show us more or less completely the condition of the progenitor of the whole group in its adult state In the great class of the Crustacea, forms wonderfully distinct from each other namely suctorial parasites cirripedes entomostraca and even the malacostraca, appear at first as larvæ under the nauplius-form and as these larvæ live and feed in the open sea, and are not adapted for any peculiar habits of life and from other reasons assigned by Fritz Müller it is probable that at some very remote period an independent adult animal resembling the nauplius existed and subsequently produced along several divergent lines of descent the above named great crustacean groups So again it is probable from what we know of the embryos of mammals, birds fishes and reptiles that these animals are the modified descendants of some ancient progenitor which was furnished in its adult state with branchiæ a swimbladder four fin like limbs and a long tail all fitted for an aquatic life

As all the organic beings extinct and recent, which have ever lived can be arranged within a few great classes and as all within each class have according to our theory been connected together by fine gradations the best, and if our collections were nearly perfect, the only possible arrangement would be genealogical descent being the hidden bond of connexion which naturalists have been seeking under the term of the Natural System On this view we can understand how it is that, in the eyes of most naturalists the structure of the embryo is even more important for classification than that of the adult. In two or more groups of animal however much they may differ from each other in structure and habits in their adult

rudimentary part is of greater size in the embryo relatively to the adjoining parts, than in the adult; so that the organ at this early age is less rudimentary, or even cannot be said to be in any degree rudimentary. Hence rudimentary organs in the adult are often said to have retained their embryonic condition.

I have now given the leading facts with respect to rudimentary organs. In reflecting on them, every one must be struck with astonishment; for the same reasoning power which tells us that most parts and organs are exquisitely adapted for certain purposes, tells us with equal plainness that these rudimentary or atrophied organs are imperfect and useless. In works on natural history, rudimentary organs are generally said to have been created 'for the sake of symmetry,' or in order 'to complete the scheme of nature.' But this is not an explanation, merely a re-statement of the fact. Nor is it consistent with itself: thus the boa-constrictor has rudiments of hind limbs and of pelvis, and if it be said that these bones have been retained 'to complete the scheme of nature,' why, as Professor Weismann asks, have they not been retained by other snakes, which do not possess even a vestige of these same bones? What would be thought of an astronomer who maintained that the satellites revolve in elliptic courses round their planets 'for the sake of symmetry,' because the planets thus revolve round the sun? An eminent physiologist accounts for the presence of rudimentary organs, by supposing that they serve to excrete matter in excess, or matter injurious to the system; but can we suppose that the minute papilla, which often represents the pistil in male flowers, and which is formed of mere cellular tissue, can thus act? Can we suppose that rudimentary teeth, which are subsequently absorbed, are beneficial to the rapidly growing embryonic calf by removing matter so precious as phosphate of lime? When a man's fingers have been amputated, imperfect nails have been known to appear on the stumps, and I could as soon believe that these vestiges of nails are developed in order to excrete horny matter, as that the rudimentary nails on the fin of the manatee have been developed for this same purpose.

On the view of descent with modification, the origin of rudimentary organs is comparatively simple; and we can understand to a large extent the laws governing their imperfect development. We have plenty of cases of rudimentary organs in our domestic productions,—as the stump of a tail in tailless breeds,—the vestige of an ear in earless breeds of sheep,—the reappearance of minute dangling horns in hornless breeds of cattle, more especially according to Youatt, in young animals,—and the state of the whole flower in the cauliflower. We often see rudiments of various parts in monsters; but I doubt whether any of these cases throw light on the origin of rudimentary organs in a state of nature, further than by showing that rudiments can be produced; for the balance of evidence clearly indicates that species under nature do not undergo great and abrupt changes. But we learn from the study of our domestic productions that the disuse of parts leads to their reduced size; and that the result is inherited.

It appears probable that disuse has been the main agent in rendering organs rudimentary. It would at first lead by slow steps to the more and more complete reduction of a part, until

islands, which have seldom been forced by beasts of prey to take flight, and have ultimately lost the power of flying. Again, an organ, useful under certain conditions, might

have aided in reducing the organ, until it was rendered harmless and rudimentary.

Any change in structure and function, which can be effected by small stages, is within the power of natural selection; so that an organ rendered, through changed habits of life, useless or injurious for one purpose, might be modified and used for another purpose. An organ might, also, be retained for one alone of its former functions. Organs, originally formed by the aid of natural selection, when rendered useless may well be variable, for their variations can no longer be checked by natural selection. All this agrees well with what we see under nature. Moreover, at whatever period of life either disuse or selection reduces an organ, and this will generally be when the being has come to maturity and has to exert its full powers of action, the principle of inheritance at corresponding ages will tend to reproduce the organ in its reduced state at the same ma-

full formed This animal never lives in the water Yet if we open a gravid female we find tadpoles inside her with exquisitely feathered gills and when placed in water they swim about like the tadpoles of the water newt Obviously this aquatic organisation has no reference to the future life of the animal nor has it any adaptation to its embryonic condition it has solely reference to ancestral adaptations it repeats a phase in the development of its progenitors

An organ serving for two purposes may become rudimentary or utterly aborted for one even the more important purpose and remain perfectly efficient for the other Thus in plants the office of the pistil is to allow the pollen tubes to reach the ovules within the ovarium The pistil consists of a stigma supported on a style but in some Compositæ the male florets which of course cannot be fecundated have a rudimentary pistil for it is not crowned with a stigma but the style remains well developed and is clot[illegible] [illegible] gan may become rudimentary for its proper purpose and be used for a distinct one in certain fishes the swimbladder seems to be rudimentary for its proper function of giving buoyancy but has become converted into a nascent breathing organ or lung Many similar instances could be given

Useful organs however little they may be developed unless we have reason to suppose that they were formerly more highly developed ought not to be considered as rudimentary They may be in a nascent condition and in progress towards further development Rudimentary organs on the other hand are either quite useless, such as teeth which never cut through the gums or almost useless such as the wings of an ostrich which serve merely as sails As organs in this condition would formerly when still less developed have been of even less use than at present they cannot fo[illegible] varia[illegible] lely by [illegible] They have been partially retained by the power of inheritance and relate to a former state of things It is however often difficult to distinguish between rudimentary and nascent organs for we can judge only by analog[illegible] ther [illegible] t, in [illegible] na [illegible] ays be

somewhat rare for beings thus provided will commonly have been supplanted by their successors with the same organ in a more perfect state and consequently will have become long ago extinct The wing of the penguin is of high service acting as a fin it may therefore represent the nascent state of the wing not that I believe this to be the case it is more probably a reduced organ modified for a new function the wi[illegible] other hand is [illegible] entary [illegible] limbs of the [illegible] organs which attain full functional development in higher vertebrates but according to the view lately advocated by Dr Günther they are probably remnants consisting of the persistent axis of a fin with the lateral rays or branches aborted The mammary glands of the Ornithorhynchus may be considered in comparison with the udders of a cow as in a nascent condition The ovigerous frena of certain cirripedes which have ceased to give attachment to the ova and are feebly developed are nascent branchiæ

Rudimentary organs in the individuals of the same species are very liable to vary in the degree of their development and in other respects In closely allied species also the extent to which the same organ has been reduced occasionally differs much This latter fact is well exemplified in the state of the wings of female moths belonging to the same family Rudimentary organs may be utterly aborted and this implies that in certain animals or plants, parts are entirely absent which analogy would lead us to expect to find in them and which are occasionally found in monstrous individuals Thus in most of th[illegible] [illegible] this rudiment occasionally becomes perfectly developed as may sometimes be seen in the common snap-dragon In tracing the homologies of any part in different members of the same class nothing is more common or in order fully to understand the relations of the parts more useful than the discovery of rudiments This is well shown in the drawings given by Owen of the leg bones of the horse ox and rhinoceros

It is an important fact that rudimentary organs such as teeth in the upper jaws of whales and ruminants can often be detected in the embryo but afterwards wholly disappear It is also I b[illegible]lieve a universal rule that

understand the leading facts in Embryology, namely the close resemblance in the individual embryo of the parts which are homologous, and which when matured become widely different in structure and function; and the resemblance of the homologous parts or organs in allied though distinct species, though fitted in the adult state for habits as different as is possible. Larvæ are active embryos, which have been specially modified in a greater or less degree in relation to their habits of life, with their modifications inherited at a corresponding early age. On these same principles,—and bearing in mind that when organs are reduced in size, either from disuse or through natural selection, it will generally be at that period of life when the being has to provide for its own wants, and bearing in mind how strong is the force of inheritance—the occurrence of rudimentary organs might even have been anticipated. The importance of embryological characters and of rudimentary organs in classification is intelligible, on the view that a natural arrangement must be genealogical.

Finally, the several classes of facts which have been considered in this chapter, seem to me to proclaim so plainly, that the innumerable species, genera and families, with which this world is peopled, are all descended, each within its own class or group, from common parents, and have all been modified in the course of descent, that I should without hesitation adopt this view, even if it were unsupported by other facts or arguments.

size in the adult If for instance the digit of an adult animal was used less and less during many generations owing to some change of habits or if an organ or gland was less and less functionally exercised we may infer that it would become reduced in size in the adult descendants of this animal but would retain nearly its original standard of development in the embryo

There remains however this difficulty After an organ has ceased being u ed and has

disuse can go on producing any further effect after the organ has once been ren lere l func tionless Some additional explanation is here requisite which I cannot give If for instance it could be proved that every part of the or ganisation tends to vary in a greater degree towar ls diminution than towards augmenta tion of size then we should be able to under stand how an organ which has become useless would be rendered independently of the effects of disuse rudimentary and would at last be wl olly suppressed for the variations towards diminished size would no longer be checked by natural selection The principle of the economy of growth explained in a former chapter by which the materials forming any part if not useful to the possessor are saved as far as pos sible will perhaps come into play in rendering a useless part rudimentary But this principle will almost necessarily be confined to the ear lier stages of the process of reduction for we cannot suppose that a minute papilla for in stance representing in a male flower the pi til of the female flower an l formed merely of cellular tissue could be further re luced or ab sorbed for the sake of economi ing nutriment

Finally as rudimentary organs by v hat ever steps tl ey may have been degrade l into their present useless condition are the record of a former state of things and have been re tained solely through the power of inher itance —we can understand on the genealogical view of classification how it is that system atists in placing organisms in their proper places in the natural system have often found rudimentary parts as useful as or even some times more useful than parts of high physio-

l al importance Rudimentary organs may

for its derivation On the view of descent with modification we may conclu le that the exis tence of organs in a rudimentary imperf ct, and useless condition or quite aborted, far from presenting a strange difficulty as tl ey as uredly do on the old doctrine of creation might even have been anticipated in accord ance with the views here explained

Summary

In this chapter I have attempted to show

all living and extinct organisms are united by complex radiating and circuitous lines of af finities into a few grand classes,—tl e rules follo ved and the difficulties encountered by naturalists in their classifications —the value set upon characters if constant and prevalent whether of high or of the most trifling im portance or as with rudimentary organs of no importance —the wide opposition in value between analogical or adaptive characters and characters of true affinity and other such rules —all naturally follow if we admit the common parentage of allied forms together with their modification through variation and natural selection with the contingencies of

l li ergence of character In con

varieties of the same species, however m u they may differ from eacl other in structure If we extend the use of this element of de

nt —the (ne certainly known cause of sim

by the terms varieties pecies genera, fam ilies order and classes

On this same view of lescent with modifica tion most of the great facts in Morphology

l ll g l le —wl etl er we look to the

and lateral homologies in eacl indivia animal and plant

On the principle of ucces i e slight varia tions, not necessarily or g nerally supervening at a very early period of life an l l eing in herited at a corre pon ling period we can

them increased size and vigour Th is ch fly wing t the forms which are crossed h ing bee exposed t som wh t diff rent cond tions of lif f r I h ascert ined by a l borious series of xperim ts that f all th nd d als of the same ariety be bjected d ring se ral generations to th sam cond tions, tl good d ed from cros in is oft n much d m nished wholly disappears. This n sid of the case On th otl id w kn w that species which ha lo g been posed t nearly uniform cond tions, whe th are sub-jected und confin m nt t n w and greatl ch ged cond t ns, th perish if th y

diffusion f tl sam speci s f r during ry lo g pe iods tl ere will alw ha e been a good hance f r wide migration by many m ans. A brok n o nt rrupted range m y ll n be accounted f by th x tinction f th spec s in th int rmed te regi ns. It cannot be d nied that w are as t very gnorant as to th f ll t nt of th various limatal and geograph l hanges wh ch l a e affected tl e

pot nt has been th influ nce f the Glacial period on th distrib tion f th sam and f all ed pec throu h t the w ld W are t rm fou dl ignorant f the man occa

probabl that this res lt is d to th ir ha g bee in fact subjected t great change in th ir cond tions of lif from bein compo nd ed of tw distinct rganisat s. H wh ll explain in definit mann wh f in tance an lephant f w ll n t breed und con-finem t in ts natr co t wh l t th do-mestic p g dog will breed freel und th most d ersified cond t ons, will t th sam tim be abl to gi d finit answ t th q estio why two distinct pecies, wh n crossed as ll as th ir h brid ff-pring are generall rend red m re or less t ril whil t t d mesticated n t es wh crossed and their mo grel ff pring re perfectl f rtil

Turnin to geographical di trib tion, th difficulties ncountered n th theory of desce t w th mod ficatio are serio en gh All th nd viduals f tl sam pecies, and all th species f th sam genus, o h gher gro p, are descended from common parents and th ref re in h distant and isolated parts of the w ld th ma now be f und the must in th co rse f ccessi g tions ha tra lled from som o point t all th oth rs. W are ften wh ll unabl t conject re h w tl is co ld h bee ffected Y t, as w ha reaso to belie that som pecies ha retained the sam specifi form f ry lo g periods of t m imm nsel lo g as m asured b ears, too much tress ought t t be laid th occasional wide

c es f th sam g nus is in som d gree lesse ed

As according t th theory of natural selec-tio an intermin ble number of int rmediate f rms must ha isted linking t geth r all th pecies in ach group by gradations as fine as are our existing arieties, t ma be asked Wh d w n t see these linkin form all around us Wh are n t all o ganic beings bl nded t g th n an inextricable chaos W th respect t xisting f rms, w sh uld re-m mbe that w ha no right to expect (cepting in rare cases) to disco er *d rectly* connecting link between th m, but nly be-tween ach and som tin t and s pplanted f rm E a w d area, which has duri g

occup ed by a closel allied pecies, w h no j t rigl t to xpect oft n t find int rmed t ar t es in th int rmediat zo s. F we ha reason to bel th t only a f w pecies f g nus und rgo change the th species becomin utt ly xtinct and l ing no mod fied proge Of th pecies which do chang nly f w w thin th sam country chang t th same tim and all mod ifications are slowly ffected I ha e also

CHAPTER XV

RECAPITULATION AND CONCLUSION

As this whole volume is one long argument, it may be convenient to the reader to have the leading facts and inferences briefly recapitulated.

That many and serious objections may be advanced against the theory of descent with modification through variation and natural selection, I do not deny. I have endeavoured to give to them their full force. Nothing at first can appear more difficult to believe than that the more complex organs and instincts have been perfected, not by means superior to, though analogous with, human reason, but by the accumulation of innumerable slight variations, each good for the individual possessor. Nevertheless, this difficulty, though appearing to our imagination insuperably great, cannot be considered real if we admit the following propositions, namely, that all parts of the organisation and instincts offer, at least, individual differences—that there is a struggle for existence leading to the preservation of profitable deviations of struct [illegible] good [illegible] the truth of these propositions cannot, I think, be disputed.

It is no doubt extremely difficult even to conjecture by what gradations many structures have been perfected, more especially amongst broken and failing groups of organic beings, which have suffered much extinction; but we see so many strange gradations in nature, that we ought to be extremely cautious in saying that any organ or instinct, or any whole structure, could not have arrived at its present state by many graduated steps. There are, it must be admitted, cases of special difficulty opposed to the theory of natural selection; and one of the most curious of these is the existence in the same community of two or three defined castes of workers or sterile female ants; but I have attempted to show how these difficulties can be mastered.

With respect to the almost universal sterility of species when first crossed, which forms so remarkable a contrast with the almost universal fertility of varieties when crossed, I must refer the reader to the recapitulation of the facts given at the end of the ninth chapter, which seem to me conclusively to show that this sterility is no more a [illegible] endowment [illegible] kinds of [illegible] it is inci[illegible] reproduc[illegible] systems of the intercrossed species. We see the truth of this conclusion in the vast difference in the results of crossing the same two species reciprocally,—that is, when one species is first used as the father and then as the mother. Analogy from the consideration of dimorphic and trimorphic plants clearly leads to the same conclusion, for when the forms are illegitimately united, they yield few or no seed, and their offspring are more or less sterile; and these forms belong to the same undoubted species, and differ from each other in no respect except in their reproductive organs and functions.

Although the fertility of varieties when intercrossed and of their mongrel offspring has been asserted by so many authors to be universal, this cannot be considered as quite correct after the facts given on the high authority of Gartner and Kolreuter. Most of the varieties which have been experimented on have been produced under domestication; and as domestication (I do not mean mere confinement) almost certainly tends to eliminate that sterility which, judging from analogy, would have affected the parent species if intercrossed, we ought not to expect that domestication would likewise induce sterility in their modified descendants when crossed. This elimination of sterility apparently follows from the same cause which allows our domestic animals to breed freely under diversified circumstances; and this again apparently follows from their having been gradually accustomed to frequent changes in their conditions of life.

A double and parallel series of facts seems to throw much light on the sterility of species, when first crossed, and of their hybrid offspring. On the one side, there is good reason to believe that slight changes in the conditions of life give vigour and fertility to all organic beings. We know also that a cross between the distinct individuals of the same variety, and between distinct varieties, increases the number of their offspring, and certainly gives to

has always been th case co sequently f rma tions much ld than any n w kn wn may l buried be eath th great oceans W th respe t t th lapse f time n t h g been s ffici nt since our plan t was co sol d ted f the assumed am unt of rgan c chang nd this objection, as rged by Sir W ll am Th mpson, is probably f th gra t as y t ad nced I can nly say firstly th t w d n t kn w t d h

species h ll changed nd th y ha changed in th mann req ired by th theory f th y ha changed l wly and a grad ted mann W cl arly see this n th fossil remains from consec t f rmat in an ably being m ch m re closely related to each th than are th foss ls from widely sepa ted f rm tions.

S ch is th m f th se ral chi f objec tions and difficulti which m y b justly rged gainst th theory and I h n w bri fly recap t lated th answ rs and xplana tions wl ich as far as I can see m y be gi n. I ha f lt these d fficult es far too h il d ring many years to d bt th w ght. B t t d serves pecial tice th t th m re im portant objections relat to q estions n hich w are confessedl gn rant n d w know h w gno ant w are W d n t know all th poss bl trans tional g ad tions betwee th simpl t and tl m t perfect gans t cannot be pret nded that w kn w ll th ried m ans f Distrib t n d ring th l g lapse f ars, that w kn w h w mperfect is th Geological Record. Se io is as th se se al object ns are, my j dgm t th y are by no m ans suffici t to rthrow th theory of desce t w th subseq t modification.

N w let us turn to th th d f the argu m t Under d m ticat w see m ch ari ab l ty caused t l ast excited by changed cond tions f lif b t oft in so bscure mann that w are t mpted t consid th ariations as po taneous. Variab lity is g erned by many comj l laws,—by correlated

growth
disuse f
surro d
culty in asce tain g n w at
prod t ons ha e been mod fied but we may saf ly inf that tl e mo t h s been large and th t modifications can be nl r ted f r l g periods. As long as th cond t ons of life remain the same, w ha reason to b l e th t a mod ficat n, wh ch has already b en inh rited f many g rati ns, m y contin e to be h ted f r an alm t nfinit u mbe f g e ti ns. O the ther hand w h ve evidence th t arial l ty wl n t has o ce com nto play doe not cease under d mesti cati n f a ry lo g pe od n r d we know that t e n ceases, f r new ar et s are till occas nally prod ced by o olde t dome ti cated producti ns

Variab l ty is n t actually caused by man h only uni t t nally expose n gani be to n w co d tio of l f and then nature acts tl ganisat n and causes it to ary B t man an and does select the ri ti ns gi n to h m by nat re and th accum lates them n any desired mann r He thus adapts an mals and plants f r h wn be fit pleasure He m y do this m tl od cally he m y d it unconsci ly by p ese ing the ind d als m t usef l pleas g to him with t any t t n of lt ring th b eed It is certain that h can largely infl nce the characte f

ti t and useful d me t b eeds. Th t many breed prod ced by man h to a larg ex t t th charact f nat ral speci s, sh wn by th in tr cabl d ubts wheth many of th m are ari t aboriginally distinct pec s.

Th re is n reaso why th principles wh ch ha acted so ffici ntly und d mestication sh uld n t ha acted d nature In th ur al f f ured indi d als and aces d ring th constantly ecurrent Struggl f E istence w see powerf l and ev acting

case f many animals and plants during a ccession f peculiar seasons, and when naturalised

allied forms on either hand for the latter from existing in greater numbers would generally be modified and improved at a quicker rate than the intermediate varieties which existed in lesser numbers so that the intermediate varieties would in the long run be supplanted and exterminated

On this doctrine of the extermination of an infinitude of connecting links between the living and extinct inhabitants of the world and at each successive period between the extinct and still older ... ry ... s? ... ns ... nce of the gradation and mutation of the forms of life? Although geological research has undoubtedly revealed the former existence of many links bringing numerous forms of life much closer together it does not yield the infinitely many fine gradations between past and present species required on the theory and this is the most obvious of the many objections which may be urged against it Why again do whole groups of allied species appear though this appearance is often false to have come in suddenly on the successive geological stages? Although we now know that organic beings appeared on this globe at a period incalculably remote long before the lowest bed of the Cambrian system was deposited why do we not find beneath this system great piles of strata stored with the remains of the progenitors of the Cambrian fossils? For on the theory such strata must somewhere have been deposited at these ancient and utterly unknown epochs of the world's history

I can answer these questions and objections only on the supposition that the geological record is far more imperfect than most geologists believe The number of specimens in all our museums is absolutely as nothing compared with the countless generations of countless species which have certainly existed The parent form of any two or more species would not be in all its characters directly intermediate between its modified offspring any more than the rock pigeon is directly intermediate in crop and tail between its descendants, the pouter and fantail pigeons We should not be able to recognise a species as the parent of another and modified species if we were to examine the two ever so closely unless we possessed most of the intermediate links and owing to the imperfection of the geological record we have no just right to expect to find so many links If two or three or even more linking forms were discovered they would simply be ranked by many naturalists as so many new species more especially if found in different geological sub stages, let their differences be ever so slight Numerous existing doubtful forms could be named which are probably varieties but who will pretend that in future ages so many fossil links will be discovered that naturalists will be able to decide whether or not these doubtful forms ought to be called varieties? Only a small portion of the world has been geologically explored Only organic beings of certain classes can be preserved in a fossil condition at least in any great number Man

... pe

... ave undergone modification though long as measured by year ... have probably been short in comparison with the periods during which they retain the same form It is the dominant and widely ra ...

... iscovery of intermediate links in any one formation less likely Local varieties will not spread into other and distant regions until they are considerably modified and improved and when they have spread and are discovered in a geological formation they appear as if suddenly created there and will be simply classed as new species Most formations have been intermittent in their accumulation and their duration has probably been shorter than the average duration of specific forms Successive formations are in most cases separated from each other by blank intervals of time of gre ...

... lternate ... evel the ... ank During these latter periods there will probably be more variability in the forms of life during periods of subsidence more extinction

With respect to the absence of strata rich in fossils beneath the Cambrian formation I can recur only to the hypothesis given in the tenth chapter namely that though our continents and oceans have endured for an enormous period in nearly their present relative positions, we have no reason to assume that this

respects resembling vari ti s. Th se are tran relations on th view that ach pecies was independently created but are intell gibl if each existed first as ariet

As each species tends by ts geom trical rate of reproduction to increase inordinately in umber and as th modified descendants of ach species will be nabled to increase by as much as they becom more d ersified in habits and structure, so as t be abl to seize on man and widely differe t places in th econ om of nature, there will be a constant tendency in natural selectio to preserve th most di ergent ffspring f any species. Hence, durin long-contin ed co rse f modification, th slight diff rences charact ristic of arieties of th sam species, tend t be g mented into the gre t diff rences characteristic of th species of th sam g us. N w and impro ed vari ties will in tably pplant and t rminat the ld less mpro ed and intermediate ari ties and thus pecies are rend red t large t t defined and distin t objects. D minant peci belongin to th larger gro ps w thin ach class t nd to gi birth to n w and d minant f rms so that ach large group t nds to becom still larg and t the sam tim more di rg nt in charact B t as all gro ps annot thus go n increasing in size f th world w uld t l ld th m th more d minant gro ps be t th less d minant. Thus t nd ncy in th large gro p t go n increasing in size and d gin in charact to th w th th in tabl contingency f much tincti n, plains th arrang m nt f all th f rms of lif m gro ps subord nat to groups, all within f w gre t classes, which has pre ailed through t all tim This grand fact of the gro ping f all rgani beings und hat is called th N tural y t m, is tt ly ine plicabl n th theory f creation.

As natural selecti acts sol ly by accum lat g slight, successi f urabl ariations, t can prod ce great or udd n mod fications t can act nl by sh rt and slow t ps. H the cano of *Natur f t sal* t m which ery fresh add tio t ur kn wl edg t nds to confirm is this theo int lligible W can see hy throughout t re th sam gen ral nd is gai ed by an almost infi nit di rsity of m ans, f rs peculiarit hen once acquired is long inh rited and tru t res already modified in man diff re t w y ha to be adapted for the same general pur pose W can, in short, see why nature is prodigal in ariet tho gh niggard in inno ation. B t why thi sh uld be a law of nature if ach pec es l as been nd pendently created n man can explain.

Many th r facts are, as t seems to me ex plicable on this theory How strang it is that a bird und r th form of woodpeck r sh uld prey on insects on th ground that upland geese wl ch rarely or n er wim should possess w bbed feet that a thrush lik bird sh uld di e and feed n b-aq atic insects and th t a petrel sl ould ha th habits and stru ture fitting t f r th life f an wk and so in ndless th r cases. B t on th w f ach pec constantly trying to increase in number w th natural selection alwa s ready to ad pt th slowly arying descendants f ach to an unoccup ed r ll-occ p ed place in

n ture f this m y be larg ly attributed to th c f selecti n. Th t bea ty accord ing to ur sense of t, is not un ersal must be admitted b ry one who will look at

patt rns, and th nam nts to th males, and som t mes to both se es of many b rds, b tt fl es, and th animals. W th bird t has oft n rend red th ce of th mal mu cal t th f mal as well as to ur ears. Fl w rs and fru t ha been rend red con p cu us b brill ant col urs contrast w th th green f l a n rd that th fl w rs m y be readily seen, sited and f rtilised b insects, and th seed dissemin ted by birds. H w t com s that ce tain col rs, sounds, and form should gi pl as re t man and the l animals,— that is, h w th sense of bea ty in its simplest f rm was first acqu red —w d not kn w any m re than h w certain od urs and fla ours w re first rend red agreeabl

As t ral selecti n acts by competition, t adapts and impro es th inhab tants f ch co try only in relati n to th co-inhab tants so that w need feel n urprise t th peci f any country alth h on th rd ary ew pposed t ha been cre ted and peciall adapted f r th t country bein be t and pplanted by tl nat ralised pro d t from an th land N ght we to marv l if all th co tri ance in t re b n t, as far as w an j dg absol t l perfect, as in

in new countries More individuals are born than can possibly survive A grain in the balance may determine which individuals shall live and which shall die —which variety or species shall increase in number and which shall decrease or finally become extinct As the individuals of the same species come in all respects into the closest competition with each other the struggle will generally be most severe between them it will be almost equally severe between the varieties of the same species and next in severity between the species of the same genus On the other hand the struggle will often be severe between beings remote in the scale of nature The slightest advantage in certain individuals at any age or during any season over those with which they come into competition or better adaptation in however slight a degree to the surrounding physical conditions will in the long run turn the balance

With animals having separated sexes there will be in most cases a struggle between the males for the possession of the females The most vigorous males or those which have most successfully struggled with their conditions of life will generally leave most progeny But success will often depend on the males having special weapons or means of defence or charms and a slight advantage will lead to victory

As geology plainly proclaims that each land has undergone great physical changes we might have expected to find that organic beings have varied under nature in the same way as they have varied under domestication And if there has been any variability under nature it would be an unaccountable fact if natural selection had not come into play It has often been asserted but the assertion is incapable of proof that the amount of variation under nature

... ort period a great result by adding up mere individual differences in his domestic productions and every one admits that species present individual differences But, besides such differences all naturalists admit that natural varieties exist which are considered sufficiently distinct to be worthy of record in systematic works. No one has drawn any clear distinction between individual differences and slight varieties or between more plainly marked varieties and sub species and species On separate continents, and on different parts of the same continent when divided by barriers of any kind and on outlying islands what a multitude of forms exist, which some experienced naturalists rank as varieties others as geographical races or sub-species and others as distinct though closely allied species!

If then animals and plants do vary let it be ever so slightly or slowly why should not variations or individual differences, which are in any way beneficial be preserved and accumulated through natural selection or the survival of the fitte t? If ...

... at ma...

can be put to this power acting during long ages and rigidly scrutinising the whole constitution structure and habits of each creature —favouring the good and rejecting the bad I can see no limit to this power in slowly and beautifully adapting each form to the m t complex relations of life The theory of natural selection even if we look no farther than this, seems to be in the highest degree probable I have already recapitulated as fairly as I could the opposed difficulties and objections now l t us turn to the pecial facts and arguments in favour of the theory

On the view tl at pecies are only stron ly marked and permanent varieties an l tl at each species first existed as a variety we can see why it is that no line of d m ...

... acknowledged to have been produced by secondary laws On this same view we can understand how it is that in a region where many pecies of a genus l a e been produced and wl re tl ...

... we might expect, as a gen ral rule to fin l it still in action and this is th case if varieties be incipient species Moreover the pecies of the larger genera, which afford the greater numl er of varieties or inc pi nt species retain to a certain degree the cl aracter of varieties for th y differ from each otl er l y a le s amount of d fference tl an do the pecie of small ...

... s round other pecies—in both

mad like our British species. On the vi w f instincts having been slowly acquired thro gh natural selecti n, w need n t marv l t som instincts being not perfect and liabl to mistakes, and at *many* in tincts ca si g oth r animals to suff

If species be nly well marked and permanent arieties, w can t nce see why th ir crossed ffspri sh uld f llow the sam com ple law in th ir d grees and kinds f resemblance to their pare ts,—in bein absorbed into each th r by ccess crosses, and n other such poi ts,—as do the rossed ff pring of acknowledged v ri t es. Th similarity would be tran fact, if species had been independently created and ari ti had been produced through secondary la s.

If w admit that th geol gical record is im perfect to an xtreme d gree th n th facts, hich th record doe gi trongl support the theory of desce t w th modificati n. N w species ha com on th ta lowly and t successi inter als and th am unt of chan alt equal intervals of tim w d l diff rent in different groups. Th extincti of species and of wh le gro ps of species which has played so con picuous part th histor f th o ganic world, almo t tabl f llow from the principl of natural selectio f ld f rm

ther descendants, causes th f rms of life, after long interval of time, t ppear as f they had changed *simultaneou l* thro gho t th orld The fact of th f ssil remains f ach formatio being in som degree termediate in characte bet ee th f ssils n th f rmations abo and below is simply xplained by their int rmediate positio in th chain of escent. Th grand fact that all tinct being can be clased w th all rece t beings, naturally follow from tl li ing and th tinct being the offspring of comm pare ts. As pecies ha generally di rged in charact during their lo g course f desce t and modification, w can und tand wh t is that the more an *cient forms, or earl pro nitors f* ach group, so ofte occupy positio in some d gree intermediate between xisti g gro ps. Recent forms are generally looked pon as being, on the le, high th scale of rganisation than ancient forms and th y must be high in so far as th later and more impro ed f rms

rrd th old r and less mpro ed

patil w th num rous be ngs till reta nin simple and but l ttl improved stru tures, fitted f r simpl condit ns f l f l ke comnat bl w th som forms ha ing ret

d rl l law f th l ng ndu ance of all ed f rm o th sam co t nt,— f mars p al in Australia, of Ed tata in Am rica, and other uch cases,—is t lligibl for with n th sam country th existing and tl ext nct w ll be closely allied by d sce t.

Looking to geo raphical distrib tion, if we adm t tl t th re ha been d ring th l ng course l g s m h m grat n from o part of th wo ld to anotl owing t f rm cl matal and geographical changes and to th many occasi nal and unkn wn means of dispersal, then w can und rstand, n the theory of descent w th modificat n, mo t of the great leading facts in Distrib tion. W an see wl y th re should be so striking a parallel m in th distri t of organi beings thro ho t pace, and in th ir geological succession thro h ut time f in both cases th being h been connected by th bond f ordinary gen tion, and th m an f mod fication ha been th sam W see th f ll mean ng of th wond ful fact, which has stru k ry tra ll nam ly that on th sam continent, und th most di rse cond t us, und h at and old

m untain and l wland, on deserts and marshes, most of th inhab tants w thin ach great class are plainl related f tl y are th descendants f th sam pro nit rs and arly col ni ts. O this sam principl of f rm r m grati n, combined n most case with modification, w can und rstand, b th *d of th Glacial period*, th id tit of som f w plants, and th close alliance f many thers, on tl most distant m untains, and n th northern and so thern t mperate zones and lik wise the cl se alliance of som of th nhab tants f th sea in th n rth rn and so th rn t mperate latitudes, th gh separated by th wh l intertropical oce n. Alth gh two co ntri s may present ph sical conditions as closely simi lar as th sam pec require w eed feel no urprise t ther inhab tants be g widely diff rent, if th y ha been f a l ng period *completely* und red from each oth f as

the case even of the human eye or if some of them be abhorrent to our ideas of fitness We need not marvel at the sting of the bee when used against an enemy causing the bee s own death at drones being produced in such great numbers for one single act and being then slaughtered by their sterile sisters at the astonishing waste of pollen by our fir trees at the instinctive hatred of the queen bee for her own fertile daughters at the Ichneumonidæ feeding within the living bodies of caterpillars or at other such cases The wonder indeed is on the theory of natural selection that more cases of the want of absolute perfection have not been detected

The complex and little known laws governing the production of varieties are the same as far as we can judge with the laws which have governed the production of distinct species In both cases physical conditions seem to have produced some direct and definite effect but how much we cannot say Thus when varieties enter any new station they occasionally assume some of the characters proper to the species of that station With both varieties and species use and disuse seem to have produced a considerable effect for it is impossible to re

as in the domestic duck or when we look at the burrowing tucu tucu which is occasionally blind and then at certain moles which are habitually blind and have their eyes covered with skin or when we look at the blind animals inhabiting the dark caves of America and Europe With varieties and species correlated variation seems to have played an important part so that when one part has been modified other parts have been necessarily modified With both parties and species reversions to long lost characters occasionally occur How inexplicable on the theory of creation is the

fact explained if we believe that these species are all descended from a striped progenitor in the same manner as the several domestic breeds of the pigeon are descended from the blue and barred rock pigeon!

On the ordinary view of each species having ... independently created ... why should spe

they all agree? Why for instance should the colour of a flower be more likely to vary in any one species of a genus if the other species possess differently coloured flowers than if all possessed the same coloured flowers? If species are only well marked varieties, of which the characters have become in a high degree permanent, we can understand this fact for they have already varied since they branched off from a common progenitor in certain characters, by which they have come to be specifically distinct from each other therefore these same characters would be more likely again to vary than the generic characters which have been inherited without change for an immense period It is inexplicable on the theory of creation why a part developed in a very unusual manner in one species alone of a genus, and therefore as we may naturally infer of great importance to that species should be eminently liable to variation but on our view this part has undergone since the several species branched off from a common progenitor an unusual amount of variability and modification and therefore we might expect the part generally to be still variable But a part may be developed in the most unusual manner like the wing of a bat and yet not be more variable than any other structure if the part be com

Glancing at instincts marvellous as some are they offer no greater difficulty than do corporeal structures on the theory of the natural selection of successive slight, but profitable modifications We can thus understand why nature moves by graduated steps in en

tion ... the admirable architectural

having descended from a common parent, and having inherited much in common we can understand how it is that allied species, ... placed under widely different conditions ... yet follow nearly the same instincts why the thrushes of tropical and temperate South America, for instance line their nests with

must be reduced or rendered rudimentary at this early age. The calf, for instance, has inherited teeth, which never cut through the gums of the upper jaw, from an early progenitor having well-developed teeth; and we may believe, that the teeth in the mature animal were formerly reduced by disuse owing to the tongue and palate, or lips, having become excellently fitted through natural selection to browse without their aid; whereas in the calf, the teeth have been left unaffected, and on the principle of inheritance at corresponding ages have been inherited from a remote period to the present day. On the view of each organism with all its separate parts having been specially created, how utterly inexplicable is it that organs bearing the plain stamp of inutility, such as the teeth in the embryonic calf or the shrivelled wings under the soldered wing-covers of many beetles, should so frequently occur. Nature may be said to have taken pains to reveal her scheme of modification, by means of rudimentary organs, of embryological and homologous structures, but we are too blind to understand her meaning.

I have now recapitulated the facts and considerations which have thoroughly convinced me that species have been modified, during a long course of descent. This has been effected chiefly through the natural selection of numerous successive, slight, favourable variations; aided in an important manner by the inherited effects of the use and disuse of parts; and in an unimportant manner, that is in relation to adaptive structures, whether past or present, by the direct action of external conditions, and by variations which seem to us in our ignorance to arise spontaneously. It appears that I formerly underrated the frequency and value of these latter forms of variation, as leading to permanent modifications of structure independently of natural selection. But as my conclusions have lately been much misrepresented, and it has been stated that I attribute the modification of species exclusively to natural selection, I may be permitted to remark that in the first edition of this work, and subsequently, I placed in a most conspicuous position—namely, at the close of the Introduction—the following words: "I am convinced that natural selection has been the main but not the exclusive means of modification." This has been of no avail. Great is the power of steady misrepresentation; but the history of science shows that fortunately this power does not long endure.

It can hardly be supposed that a false theory would explain, in so satisfactory a manner as does the theory of natural selection, the several large classes of facts above specified. It has recently been objected that this is an unsafe method of arguing; but it is a method used in judging of the common events of life, and has often been used by the greatest natural philosophers. The undulatory theory of light has thus been arrived at; and the belief in the revolution of the earth on its own axis was until lately supported by hardly any direct evidence. It is no valid objection that science as yet throws no light on the far higher problem of the essence or origin of life. Who can explain what is the essence of the attraction of gravity? No one now objects to following out the results consequent on this unknown element of attraction; notwithstanding that Leibnitz formerly accused Newton of introducing "occult qualities and miracles into philosophy."

I see no good reason why the views given in this volume should shock the religious feelings of any one. It is satisfactory, as showing how transient such impressions are, to remember that the greatest discovery ever made by man, namely, the law of the attraction of gravity, was also attacked by Leibnitz, "as subversive of natural, and inferentially of revealed, religion." A celebrated author and divine has written to me that "he has gradually learnt to see that it is just as noble a conception of the Deity to believe that He created a few original forms capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws."

Why, it may be asked, until recently did nearly all the most eminent living naturalists and geologists disbelieve in the mutability of species. It cannot be asserted that organic beings in a state of nature are subject to no variation; it cannot be proved that the amount of variation in the course of long ages is a limited quality; no clear distinction has been, or can be, drawn between species and well-marked varieties. It cannot be maintained that species when intercrossed are invariably sterile and varieties invariably fertile; or that sterility is a special endowment and sign of creation. The belief that species were immutable productions was almost unavoidable as long as the history of the world was thought to be of short duration; and now that we have acquired some idea of the lapse of time, we are too apt

the relation of organism to organism is the most important of all relations and as the two countries will have received colonists at various periods and in different n on n om e

(_ = en different

On this view of migration with subsequent modification we see why oceanic islands are inhabited by only few species but of these why many are peculiar or endemic forms We clearly see why species belonging to those groups of animals which cannot cross wide spaces of the ocean as frogs and terrestrial mammals do not inhabit oceanic islands and why on the other hand new and peculiar species of bats animals which can traverse the ocean ar f nt from ence of ands and t e of all other terrestrial mammals are facts utterly inexplicable on the theory of independent acts of creation

The existence of closely allied or representative species in any two area implies on the theory of descent with modification that the same parent forms formerly inhabited both areas and we almost invariably find that wherever many closely allied species inhabit two areas some identical species are still common to both Wherever many closely allied yet distinct species occur doubtful forms and varieties belonging to the same groups likewise occur It is a rule of high generality that the inhabitants of each area are related to the inhabitants of the nearest source whence immigrants might have been derived We see this in the striking relation of n d n

and animals of the neighbouring American mainland and of those of the Cape de Verde Archipelago and of the other African islands to the African mainland It must be admitted that these facts receive no explanation on the theory of creation

The fact as we have seen that all past and present organic beings can be arranged within a few great classes in groups subordinate to groups and with the extinct groups often falling in between the recent groups is intelligible on the theory of natural selection with its contingencies of extinction and divergence of character On these same principles we see how it is that the mutual affinities of the forms within each class are so complex and circuitous We see why certain characters are far more serviceable than others for classification —why adaptive cha

rom rudimentary parts, though of no service to the beings, are often of high classificatory value

inheritance or community of descent The Natural System is a genealogical arrangement with the acquired grades of difference marked by the terms, varieties, species genera, families &c and we have to discover the lines of descent by the most permanent characters whatever they may be and of however slight vital importance.

The similar framework of bones in the hand of a man wing of a bat fin of the porpoise and leg of the horse —the same number of vertebræ forming the neck of the giraffe and of the elephant —and innumerable other such facts, at once explain themselves on the theory of descent with slow and slight successive modifications The similarity of pattern in the wing and in the leg of a bat though used for such different purpose —in the jaws and legs of a crab —in the petal stamens and pistils of a flower is likewise to a large extent intelligible on the view of

classes.

On the principle of successive variations not always supervening at an early age and being inherited at a corresponding not early period of life we clearly see why the embryos of mammals birds reptile and fishes should be so closely similar and so unlike the adult forms We may cease marvelling at the embryo of an air breathing mammal or bird having branchial slits and arteries running in loops like those of a fish which has to breathe the air dissolved in water by the aid of well-developed branchiæ.

Disuse aided sometimes by natural selection will

caning of rudimentary organs. But disuse and selection will generally act on each creature when it has come to maturity and has to play its full part in the struggle for existence and will thus have little power on an organ during early life hence the organ will

are suddenly given birth, through quite unexplained means, to new and totally different forms; but, as I have attempted to show, no weighty evidence can be opposed to the admission of great and abrupt modifications. Under a scientific point of view, and as leading to further investigation, but little advantage is gained by believing that new forms are suddenly developed in an inexplicable manner from old and widely different forms, over the old belief in the creation of species from the dust of the earth.

It may be asked how far I extend the doctrine of the modification of species. The question is difficult to answer, because the more distinct the forms are which we consider, by so much the arguments in favour of community of descent become fewer in number and less in force. But some arguments of the greatest weight extend very far. All the members of whole classes are connected together by a chain of affinities, and all can be classed on the same principle, in groups subordinate to groups. Fossil remains sometimes tend to fill up very wide intervals between existing orders.

Organs in a rudimentary condition plainly show that an early progenitor had the organ in a fully developed condition; and this in some cases implies an enormous amount of modification in the descendants. Throughout whole classes various structures are formed on the same pattern, and at a very early age the embryos closely resemble each other. Therefore I cannot doubt that the theory of descent with modification embraces all the members of the same great class or kingdom. I believe that animals are descended from at most only four or five progenitors, and plants from an equal or lesser number.

Analogy would lead me one step farther, namely, to the belief that all animals and plants are descended from some one prototype. But analogy may be a deceitful guide. Nevertheless all living things have much in common, in their chemical composition, their cellular structure, their laws of growth, and their liability to injurious influences. We see this even in so trifling a fact as that the same poison often similarly affects plants and animals; or that the poison secreted by the gall-fly produces monstrous growths on the wild rose or oak-tree. With all organic beings, excepting perhaps some of the very lowest, sexual production seems to be essentially similar. With all, as far as is at present known, the germinal vesicle is the same; so that all organisms start from a common origin. If we look even to the two main divisions—namely, to the animal and vegetable kingdoms—certain low forms are so far intermediate in character that naturalists have disputed to which kingdom they should be referred. As Professor Asa Gray has remarked, "The spores and other reproductive bodies of many of the lower algæ may claim to have first a characteristically animal, and then an unequivocally vegetable existence." Therefore, on the principle of natural selection with divergence of character, it does not seem incredible that, from such low and intermediate form, both animals and plants may have been developed; and, if we admit this, we must likewise admit that all the organic beings which have ever lived on this earth may be descended from some one primordial form. But this inference is chiefly grounded on analogy, and it is immaterial

clude that only a very few have left modified descendants. For, as I have recently remarked, in regard to the members of each great kingdom, such as the Vertebrata, Articulata, &c., we have distinct evidence in their embryological, homologous, and rudimentary structures that within each kingdom all the members are descended from a single progenitor.

When the views advanced by me in this volume, and by Mr. Wallace, or when analogous views on the origin of species are generally admitted, we can dimly foresee that there will be a considerable revolution in natural history. Systematists will be able to pursue their labours as at present; but they will not be incessantly haunted by the shadowy doubt whether this or that form be a true species. This, I feel sure, and I speak after experience, will be no slight relief. The endless disputes whether or not some fifty species of British brambles are good species will cease. Systematists will have only to decide (not that this will be easy) whether any form be sufficiently constant and distinct from other forms, to be capable of definition; and if definable, whether the differences be sufficiently important to deserve a specific name. This latter point will become a far more essential consideration than it is at present; for differences, however slight, between any two forms, if not blended by intermediate gradations, are looked at by most

to assume without proof that the geological record is so perfect that it would have afforded us plain evidence of the mutation of species if they had undergone mutation

But the chief cause of our natural unwillingness to admit that one species has given birth to clear and distinct species is that we are always slow in admitting great changes of which we do not see the steps The difficulty is the same as that felt by so many geologists when Lyell first insisted that long lines of inland cliffs had been formed and great valleys excavated by the agencies which we see still at work The mind cannot possibly grasp the full meaning of the term of even a million years it cannot add up and perceive the full effects of many slight variations accumulated during an almost infinite number of generations

Although I am fully convinced of the truth of the views given in this volume under the form of an abstract I by no means expect to convince experienced naturalists whose minds are stocked with a multitude of facts all viewed during a long course of years from a point of view directly opposite to mine It is so easy to hide our ignorance under such expressions as the plan of creation unity of design &c and to think that we give an explanation when we only re state a fact Any one whose disposition leads him to attach more weight to unexplained difficulties than to the explanation of a certain number of facts will certainly reject the theory A few naturalists endowed with much flexibility of mind and who have already begun to doubt the immutability of species may be influenced by this volume but I look with confidence to the future —to young and rising naturalists who will be able to view both sides of the question with impartiality Whoever is led to believe that species are mutable will do good service by conscientiously expressing his conviction for thus only can the load of prejudice by which this subject is overwhelmed be removed

Several eminent naturalists have of late published their belief that a multitude of reputed species in each genus are not real species but that other species are real that is have been independently created This seems to me a strange conclusion to arrive at They

quently have all the external characteristic

features of true species,—they admit that these have been produced by variation but they refuse to extend the same view to other and slightly different forms Nevertheless they do not pretend that they can define or even conjecture which are the created forms of life, and which are those produced by secondary laws They admit variation as a *vera causa* in one case they arbitrarily reject it in another without assigning any distinction in the two cases The day will come when this will be given as a curious illustration of the blindness of preconceived opinion These authors seem no more startled at a miraculous act of creation than at an ordinary birth But do they really believe that at innumerable periods in the earth s history certain elemental atoms have been commanded suddenly to flash into living tissues? Do they believe that at each supposed act of creation one individual or many were produced? Were all the infinitely numerous kinds of animals and plants created as eggs or seed or as full grown? and in the case of mammals were they created bearing the false marks of nourishment from the mother s womb? Undoubtedly some of the e same

wh

has been maintained by several authors that it is as easy to believe in the creation of a million beings as of one but Maupertuis philosophical axiom of least action leads the mind more willingly to admit the smaller number and certainly we ought not to believe that innumerable beings within each great class have been created with plain but deceptive marks of descent from a single parent.

each species and I have been much censured for having thus expressed myself But undoubtedly this was the general belief when the first edition of the present work appeared I formerly spoke to very many naturalists on the subject of evolution and never once met

are however some who still think that species

and not by miraculous acts of creation and as the most important of all causes of organic change is one which is almost independent of altered and perhaps suddenly altered physical conditions, namely, the mutual relation of organism to organism,—the improvement of one organism entailing the improvement or the extermination of others; it follows, that the amount of organic change in the fossils of consecutive formations probably serves as a fair measure of the relative though not actual lapse of time. A number of species, however, keeping in a body might remain for a long period unchanged, whilst within the same period several of these species by migrating into new countries and coming into competition with foreign associates, might become modified; so that we must not overrate the accuracy of organic change as a measure of time.

In the future I see open fields for far more important researches. Psychology will be securely based on the foundation already well laid by Mr. Herbert Spencer, that of the necessary acquirement of each mental power and capacity by gradation. Much light will be thrown on the origin of man and his history.

Authors of the highest eminence seem to be fully satisfied with the view that each species has been independently created. To my mind it accords better with what we know of the laws impressed on matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and death of the individual. When I view all beings not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Cambrian system was deposited, they seem to me to become ennobled. Judging from the past, we may safely infer that not one living species will transmit its unaltered likeness to a distant futurity. And of the species now living very few will transmit progeny of any kind to a far distant futurity; for the manner in which all organic beings are grouped, shows that the greater number of species in each genus, and all the species in many genera, have

to the larger and dominant groups within each
class, which will ultimately prevail and procreate

we may feel certain that the ordinary succession by generation has never once been broken, and that no cataclysm has desolated the whole world. Hence we may look with some confidence to a secure future of great length. And as natural selection works solely by and for the good of each being, all corporeal and mental endowments will tend to progress towards perfection.

It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us. These laws, taken in the largest sense, being Growth with Reproduction; Inheritance which is almost implied by reproduction; Variability from the indirect and direct action of the conditions of life, and from use and disuse: a Ratio of Increase so high as to lead to a Struggle for Life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less-improved forms. Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.

naturalists as sufficient to raise both forms to the rank of species

Hereafter we shall be compelled to acknowledge that the only distinction between species and well marked varieties is that the latter are known or believed to be connected at the present day by intermediate gradations whereas species were formerly thus connected Hence without rejecting the consideration of the present existe [illegible] mediate grada [illegible] shall be led to [illegible] lue higher the [illegible] veen them It is quite possible that forms now generally acknowledged to be merely varieties may hereafter be thought worthy of pecific names and in this case scientific and common language will come into accordance In short w [illegible] h [illegible]

[illegible] nce This may not be a cheering prospect but we shall at least be free from the vain search for the undiscovered and undiscoverable essence of the term species

The other and more general departments of natural history will rise greatl [illegible]

[illegible] ve characters rudimentary and aborted organs &c will cease to be metaphorical and will have a plain signification When we no longer look at an organic being as a savage looks at a ship as something wholly beyond his comprehension when we regard every production of nature as one which has had a long history when we contemplate every complex structure and instinct as the summing up of many contrivances each useful to the possessor in the same way as any great mechanical invention is the summing up of the labour the experience the reason and even the blunders of numerous workmen when we thus view each organic being how far more interesting—I speak from experience—does the study of natural history become!

A grand and almost untrodden field of inquiry will be opened on the causes and laws of variation on correlation on the effects of use and disuse on the direct action of external conditions, and so forth The study of domestic productions will rise immensely in value A new variety raised by man will be a more important and interesting subject for study than one more species added to the infinitude of already recorded pecies. Our classifications will come to be as far as they can be so made genealogies and will then truly give what may be called the plan of creation The rules for classifying will no doubt become simpler when we have a definite object in view We possess no pedigrees or armorial bearings and we have to discover and trace the many diverging lines of descent in our natural genealogies by characters of any kind which have long been inherited Rudimentary organs will speak infallibly with respect to the nature of long lost structures Species and groups of species which are called aberrant, and which may fancifully be called living fossils, will aid us in forming a picture of the ancient forms of life Embryology will often reveal to us the structure in some degree obscured of the prototype of each great class

When we feel assured that all the individuals of the same pecies and all the closely allied species of most genera, have within a not very remote period descended from one parent and have migrated from some one birth place and when we better know the many means of migration then by the light which geology now throws and will continue to throw on former changes of climate and of the level of the land we shall surely be enabled to trace in an admirable manner the former migrations of the inhabitants of the whole world Even at present, by comparing the differences between the inhabitants of the sea on the opposite ides of a continent, and the nature of the various inhabitants on that continent, in relation to their apparent means of immigration some light can be thrown on ancient geography

The noble science of Geology loses lorr from the extreme imperfection of the record The crust of the earth with its imbedded remains must not be looked at as a well filled museum but as a poor collection made at hazard and at rare intervals. The accumulation of each great fossiliferous formation will be recognised as having depended on an unusual concurrence of favourable circ [illegible]

[illegible] we will som [illegible]

[illegible] late as strictly contemporaneous two formations, which do not include many identical species by the general succession of the forms of life As pecies are produced and exterminated by slowly acting and still existing causes,

GLOSSARY

OF THE PRINCIPAL SCIENTIFIC TERMS USED IN THE PRESENT VOLUME

Aberrant. Forms or groups of animals or plants which deviate in important characters from their nearest allies, so as not to be easily included in the same group with them, are said to be aberrant.

Aberration (in Optics). In the refraction of light by a convex lens the rays passing through different parts of the lens are brought to a focus at slightly different distances,—this is called *spherical aberration*; at the same time the coloured rays are separated by the prismatic action of the lens and likewise brought to a focus at different distances,—this is *chromatic aberration*.

Abnormal. Contrary to the general rule.

Aborted. An organ is said to be aborted, when its development has been arrested at a very early stage.

Albinism. Albinos are animals in which the usual colouring matters characteristic of the species have not been produced in the skin and its appendages. Albinism is the state of being an albino.

Algæ. A class of plants including the ordinary seaweeds and the filamentous fresh-water weeds.

Alternation of Generations. This term is applied to a peculiar mode of reproduction which prevails among many of the lower animals, in which the egg produces a living form quite different from its parent, but from which the parent form is reproduced by a process of budding, or by the division of the substance of the first product of the egg.

Ammonites. A group of fossil, spiral, chambered shells, allied to the existing pearly Nautilus, but having the partitions between the chambers waved in complicated patterns at their junction with the outer wall of the shell.

Analogy. That resemblance of structures which depends upon similarity of function, as in the wings of insects and birds. Such structures are said to be *analogous*, and to be *analogues* of each other.

Animalcule. A minute animal: generally applied to those visible only by the microscope.

Annelids. A class of worms in which the surface of the body exhibits a more or less distinct division into rings or segments, generally provided with appendages for locomotion and with gills. It includes the ordinary marine worms, the earth-worms, and the leeches.

Antennæ. Jointed organs appended to the head in insects, Crustacea and centipedes, and not belonging to the mouth.

Anthers. The summits of the stamens of flowers, in which the pollen or fertilising dust is produced.

Aplacentalia, Aplacentata or Aplacental Mammals. *See* Mammalia.

Archetypal. Of or belonging to the Archetype, or ideal primitive form upon which all the beings of a group seem to be organised.

Articulata. A great division of the Animal Kingdom characterised generally by having the surface of the body divided into rings called segments, a greater or less number of which are furnished with jointed legs (such as insects, crustaceans and centipedes).

Asymmetrical. Having the two sides unlike.

Atrophied. Arrested in development at a very early stage.

Balanus. The genus including the common acorn-shells which live in abundance on the rocks of the sea-coast.

Batrachia. A class of animals allied to the reptiles, but undergoing a peculiar metamorphosis, in which the young animal is generally aquatic and breathes by gills. (*Examples*, frogs, toads,

[illegible]

bodied animals, furnished with a bivalve shell, attached to submarine objects by a stalk which passes through an aperture in one of the valves, and furnished with fringed arms, by the action of which food is carried to the mouth.

Branchiæ. Gills or organs for respiration in water.

Branchial. Pertaining to gills or branchiæ.

Cambrian System. A series of very ancient Palæozoic rocks, between the Laurentian and the Silurian. Until recently these were regarded as the oldest fossiliferous rocks.

Canidæ. The dog-family, including the dog, wolf, fox, jackal, &c.

Carapace. The shell enveloping the anterior part of the body in crustaceans generally; applied also to the hard shelly pieces of the cirripedes.

Carboniferous. This term is applied to the great formation which includes, among other rocks, the coal-measures. It belongs to the oldest, or Palæozoic, system of formations.

Caudal. Of or belonging to the tail.

Cephalopods. The highest class of the Mollusca, or soft-bodied animals, characterised by having the

I am indebted to the kindness of Mr. W. S. Dallas for this Glossary, which has been given because several readers have complained to me that some of the terms used were unintelligible to them. Mr. Dallas has endeavoured to give the explanations of the terms in as popular a form as possible.

FLORA. The totality of the plants growing naturally in a country or during a given geological period.

FLORETS. Flowers imperfectly developed in some respects, and collected into a dense spike or head, as in the grasses, the dandelion, &c.

FETAL. Of or belonging to the fœtus, or embryo in course of development.

FORAMINIFERA. A class of animals of very low organization, and generally of small size having a jelly-like body from the surface of which delicate filaments can be given off and retracted for the prehension of external objects, and having a calcareous or sandy shell, usually divided into chambers, and perforated with small apertures.

FOSSILIFEROUS. Containing fossils.

FOSSORIAL. Having a faculty of digging. The Fossorial Hymenoptera are a group of wasp-like insects, which burrow in sandy soil to make nests for their young.

FRENUM (pl. FRENA). A small band or fold of skin.

FUNGI (sing. FUNGUS). A class of cellular plants, of which mushrooms, toadstools, and moulds, are familiar examples.

FURCULA. The forked bone formed by the union of the collar-bones in many birds, such as the common fowl.

GALLINACEOUS BIRDS. An order of birds of which the common fowl, turkey, and pheasant, are well-known examples.

GALLUS. The genus of birds which includes the common fowl.

GANGLION. A swelling or knot from which nerves are given off as from a centre.

GANOID FISHES. Fishes covered with peculiar enamelled bony scales. Most of them are extinct.

GERMINAL VESICLE. A minute vesicle in the eggs of animals, from which development of the embryo proceeds.

GLACIAL PERIOD. A period of great cold and of enormous extension of ice upon the surface of the earth. It is believed that glacial periods have occurred repeatedly during the geological history of the earth, but the term is generally applied to the close of the Tertiary epoch, when nearly the whole of Europe was subjected to an arctic climate.

GLAND. An organ which secretes or separates some peculiar product from the blood or sap of animals or plants.

GLOTTIS. The opening of the windpipe into the œsophagus or gullet.

GNEISS. A rock approaching granite in composition, but more or less laminated, and really produced by the alteration of a sedimentary deposit after its consolidation.

GRALLATORES. The so-called wading-birds (storks, cranes, snipes, &c.), which are generally furnished with long legs, bare of feathers above the heel, and have no membranes between the

GRANITE. A rock consisting essentially of crystals of felspar and mica in a mass of quartz.

HABITAT. The locality in which a plant or animal naturally lives.

HEMIPTERA. An order or sub-order of insects, characterised by the possession of a jointed beak or rostrum, and by having the fore-wings horny in the basal portion and membranous at the extremity, where they cross each other. This group includes the various species of bugs.

HERMAPHRODITE. Possessing the organs of both sexes.

HOMOLOGY. That relation between parts which results from their development from corresponding embryonic parts, either in different animals, as in the case of the arm of man, the fore-leg of a quadruped, and the wing of a bird; or in the same individual, as in the case of the fore and hind legs in quadrupeds, and the segments or rings and their appendages of which the body of a worm, a centipede, &c., is composed. The latter is called *serial homology*. The parts which stand in such a relation to each other are said to be *homologous*, and one such part or organ is called the *homologue* of the other. In different plants the parts of the flower are homologous, and in general these parts are regarded as homologous with leaves.

HOMOPTERA. An order or sub-order of insects having (like the Hemiptera) a jointed beak, but in which the fore-wings are either wholly membranous or wholly leathery. The Cicadæ, frog-hoppers, and Aphides, are well-known examples.

HYBRID. The offspring of the union of two distinct species.

HYMENOPTERA. An order of insects possessing biting jaws and usually four membranous wings in which there are a few veins. Bees and wasps are familiar examples of this group.

HYPERTROPHIED. Excessively developed.

ICHNEUMONIDÆ. A family of hymenopterous insects, the members of which lay their eggs in the bodies or eggs of other insects.

IMAGO. The perfect (generally winged) reproductive state of an insect.

INDIGENES. The aboriginal animal or vegetable inhabitants of a country or region.

INFLORESCENCE. The mode of arrangement of the flowers of plants.

INFUSORIA. A class of microscopic animalcules, so called from their having originally been observed in infusions of vegetable matters. They consist of a gelatinous material enclosed in a delicate membrane, the whole or part of which is furnished with short vibrating hairs (called cilia), by means of which the animalcules swim through the water or convey the minute particles of their food to the orifice of the mouth.

INSECTIVOROUS. Feeding on insects.

INVERTEBRATA, or INVERTEBRATE ANIMALS. Those animals which do not possess a backbone or spinal column.

mouth surrounded by a greater or less number of fleshy arms or tentacles which in most living species are furnished with sucking-cups (*Examples* cuttle-fish nautilus)

Cetacea An order of Mammalia including the e

Chelonia An order of reptiles including the turtles tortoises, &c

Cirripedes An order of crustaceans including the barnacles and acorn shells Their young resemble those of many other crustaceans in form but when mature they are always attached to other objects, either directly or by means of a stalk and their bodies are enclosed by a calcareous shell composed of several pieces two of which can open to give issue to a bunch of curled jointed tentacles, which represent the limbs

Coccus, The genus of insects including the cochineal In these the male is a minute winged fly and the female generally a motionless berry-like mass

Cocoon A case usually of silky material in which insects are frequently enveloped during the second or resting stage (pupa) of their existence. The term cocoon stage is here used as equivalent to pupa stage

Cœlospermous A term applied to those fruits of the Umbelliferæ which have the seed hollowed on the inner face

Coleoptera beetles an order of insects having a biting mouth and the first pair of wings more or less horny forming sheaths for the second pair and usually meeting in a straight line down the middle of the back

Column A peculiar organ in the flowers of orchids in which the stamens, style and stigma (or the reproductive parts) are united

Composite or Compositous Plants, Plants in which the inflorescence consists of numerous small flowers (florets) brought together into a dense head the base of which is enclosed by a common [illegible] (*Examples* the daisy dandelion &c)

Confervæ, The filamentous weeds of fresh water

Conglomerate A rock made up of fragments of rock or pebbles cemented together by some other material

Corolla The second envelope of a flower usually composed of coloured leaf-like organs (petals) which may be united by their edges either in the basal part or throughout

Correlation The normal coincidence of one phenomenon or character &c with another

Corymb A bunch of flowers in which those springing from the lower part of the flower stalk are supported on long stalks so as to be nearly on a level with the upper

Cotyledons, The first or seed leaves of plants

Crustaceans, A class of articulated animals having the skin of the body generally more or less hardened by the deposition of calcareous matter breathing by means of gills (*Examples* crab, lobster shrimp &c)

Curculio The old generic term for the beetles known as weevils characterised by their four-jointed feet and by the head being produced into a sort of beak upon the sides of which the antennæ are inserted

Cutaneous Of or belonging to the skin.

Degradation The wearing down of land by the action of the sea or of meteoric agencies.

Denudation The wearing away of the surface of the land by water

and the old wood (exogenous growth) and by the reticulation of the veins of the leaves. The parts of the flowers are generally in multiples of five

Differentiation The separation or discrimination of parts or organs which in simpler forms of life are more or less united

Dimorphic Having two distinct forms —Dimorphism is the condition of the appearance of the same species under two dissimilar forms

Diœcious Having the organs of the sexes upon distinct individuals.

Diorite, A peculiar form of greenstone

Dorsal, Of or belonging to the back

Edentata A peculiar order of quadrupeds, characterised by the absence of at least the middle incisor (front) teeth in both jaws. (*Examples,* the

constitute the true organ of flight.

Embryo The young animal undergoing development within the egg or womb

Embryology The study of the development of the embryo

l

t a small proportion of shells identical with the species now living

Ephemerous Insects Insects allied to the May-fly

Fauna The totality of the animals naturally in-

FLORA. The totality of the plants growing naturally in a country or during a given geological period.

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mouth surrou ded by a gr ater or l s numb r of fl hy rms r tent cles which in most liv g spec es re furn hed with sucking cup (*Ex mpl s cuttle-f h autilus*)

CETACEA An ord r of Mamm l a including the wh les d lphins &c. having the form f the body fish like th skin naked and only the f re-l mbs developed

CHELONIA An rder f rept les includi g the tur-

th s of m ny othe crustacean in form but wh en mature they are al ays attach d to ther objects ther d rectly or by mean of a st lk and the r bodies are encl ed by a c lcareous hell mposed of several piec s two f wh ch can pen to g ve issue to a bunch of curled jointed tenta cles wh ch repre ent th limb

COCCUS The g nus of insects includ ng th cochi al In the e the m l is a n nut i ged fly a d the female generally a m tio les berry l ke m

COCOON A case usually of s lky mat rial in wh ch ects re frequer tly envel ped d ring the seco d or re ting stage (p pa) of th ir ist ce The term c coon stage is here used as equi alent to pupa stage

CŒLOSPERMOUS A term appl ed to those fru ts of the Umbell f rae h ch b ve th seed hollowed on the in r f ce

COLEOPTERA b tle an rder f in ects ha i g b t g m uth nd th first pa r f w gs m re r less horny f rm g heaths for the econd p and u ually meeting in a stra ght l e down the m ddle of the back

COLUMN A pecul r g n in the flowers of orchids i i l h the tamens ty le a d stigm (r the re-productive parts) ar united

COMPO IT E COMPOSITOUS PLANTS Plants in h ch the fl rese nce c i sts of numerous m ll flo e s (fl ets) bro gh t t g th er int a den e he d the base of wh ch is l ed by a commo en el pe (*F a yle the d y l del &c*)

CONFERVÆ, Th filam ntous w eds f f e h t r

CONGLOMERATE, A rock m de p of f gm ts f rock p bbl s c me ted t gether by s me ther n t al

COROLLA The eco d e l pe f a flow r usu lly mpos d f l ur d le f l ke rg (p tals) h h m y b u ted by th r dg s e th r n the basal p rt r th rough ut

C r Th rmal co n d ce of phe-

CRU T CEANS, A lass f t culated m b th e k n of the body ge rally m e r l ss h rd en d by the depo t on of calcareous m tt r

breath ng by me ns of g lls (*Exampl s cr b, lobster h imp &c*)

CURCULIO The old gener term f the beetles kno n as ee ls ch a acterised by their f ur jo nted feet and by th e h d being produced to a sort of be k up n the s des of hich the antennæ re inserted

CUTANEOUS, Of or belong g to the skin.

DEGRADATION The w earing do n of l nd by the action f the ea r of meteor c gencies.

DENUDATION The we r g away f the surf ce of th e l d by w t r

DEVONIAN SYSTEM r form t on A seri s of P læo-c rocks i clud g the Old Red S nd to

DICOTYLEDONS r DICOTYLEDONOUS PLANTS, A clas of pl ts charact ri ed by havi g t seed l a es, by the format n of n wood b t e n th bark and th e old w od (ex g nous gro th) d by the ret culation f the ins f the lea s. The p rts of th flow rs are gen er lly i i n ult ples of fi e

DIFFERENTIATION The par tion o d scrimi t n of p rt or organ wh ich sir pl r f rms of l f a e m re or less un ted

DIŒCIOUS H i g the o g s of the xes upo dis-t ct i d d ls

DIORITE, A p uli r f rm f gre nst ne

DORSAL, Of r belong g t the back

EDENTATA A pecul ar rder f q adrupeds, har acter sed by th b ence f t l ast th m ddl n-c r (f o t) t th i both ja s (*Example the*

E

co t tute the t e rga s f fl ght.

EMBRYO Th young i al d go g d l p-ment th the gg r wo b

EMBRYOLOGY Th tudy of the dev lopme t of th embryo

ENDEMIC Peculiar to a g en locality

E OMOST A d n f th e class C ustacea.

are g rally f mall ze

EOCENE Th a li t f the th ee d v ons f the T rt y poch f geol g ts Rock f th is g con ta n m ll pr p ti f h lls ide t cal th pec e r l i g

EPHEMEROUS INSECTS, I sect ll ed t the M y fly

FAUN The t t l ty f th e n m ls turally in-h b

FE

FERAL, H v ng become wild from tate of culti t n or d mest cation

FLORA, Th t tality f th pla ts gro g tur- ally in country dur g g geol g cal p od.

FLORETS, Fl ers mperfectly d l ped som respects, d collected t d nse p k h d as in the grasses, th da d l &c.

FŒTAL, Of bel nging t th fœtus, bry

f th ry g

FRE. UM (pl. FRE) A mall b d f ld f skin.

FU (sing FU US) A class of cellular pl ts, f hich mushrooms, toadstools, nd m ulds, are familiar ampl s.

F RCUL Th f ked bo f rmed by th f th collar-bo es m y b rds, uch as th com m f l.

GALLI EO B RDS, A rd of birds f which th comm f wl, turk y d ph as t, re ll-kn mples

G LLUS, Th g us f b rd h h clud th com m f l

GA LL A lli g k t from h ch rives re ff as from ce tre

GA FISHES, Fish co red th peculiar na lled b y scal Most f th m are t t.

GERMI VES LE, A mi t es cl th gg f nimals, from l ch d vel pm t f th mbry proceeds

GLACI l ERI A p od f gre t cold d f m us t ns l ce po th urf ce of th arth It is bel ed th t gla l periods h oc- curred repe tedly dur g th geol g cal history f th th, b t th t rm is g ll ppl ed t th l se of th T tiary poch ll ly th h l f Europe bjected t ret lim t

GLA A g Inch ecr t separates som pecul p od ct from th blood sap f m ls pla ts

GLOTTIS, Th pe g f th dp pe t th œs pl gu gull t

G EISS, A rock pp oach g gr t co po t n, b t m re less laminated, d really prod ced b th lter t f sedim tary d po t aft co isol dat

GRALLA ES, Th o-called d g birds (t ks, cra es pes, &c.) hich are g rally fur hed th l ng legs, bare of f th rs bo heel, nd ha m mbranes bet ee th t es.

GRA E, A rock co is t g esse t ally f crystals f f l p d mas of q tz.

HABI T Th local ty l a pla t m l t rally l es.

HEM PT t rd b-order of sects, char- ct l by tl poss ss of j ted be k rost d by ha g th f re- g h) tl b l j t nd m mb us t th trem ty l re tl y ross h ther Th gro p r es f bugs.

tl ca f tl rt th f rel g jual l t l g f b rd th sam f

ped

H mol gy Th p ts l h t d ich relat t h th re as d t be h mologo nd uch p rt g called tl h molog d tl the l d ff re t p ls ts tl parts of the fl re h m l g us, d ge l these p t re re- garded as h k gous th l

H M PTERA t rd f sects ha (lik th H m p t ra) j ted beak, b t h h th f re- g re th h lly men bra us h lly l th ry Th C cadæ frcg h ppe s, d Aph d s, are ll-k mples.

H n, Th off pri g of th m of t d t t

I n ECTM E, A f ly f hym pt ro s sects, th m mbers f h h l y th tl bod gg of th sects.

IM O, Th perfect (ge lly ged) reproduct t t sect.

I E ES, Tl bo g l mal t bl n- h b ta ts of co try gt n.

I LO ESCE E, Th mod f rra g m t f tl fl ers of pla ts.

I FU IA A las f m roscop imal ules, n called from th ir ha g g ally bee bserved du f re et bl m tt rs. Th y co t f g lat us m t l losed d l cat bra th h l u t f h h fur hed tl h t brat g hairs (called l) by ns f h ch th m l l m thro gh th t co y th m t p rt l f th ir food t th fice f tl th

I ECTI S, I ed g sects.

I ER EB I ER EBRA A MALS, Thos m ls h h d t possess backb p l colum

Lacunæ, Spaces l ft among the t sues in some of the lower animals and serving in pl c of vessels f r the circul tion of the flu ds of the body

Lamellated Furnished with l mellæ or little plates

Larva (pl **Larvæ**) The first co dition of an i isect at its issuing f om the egg when it is usu lly in the form of a grub caterpillar or maggot.

Larynx, The upper part of the windp pe opening into the gullet.

Laurentian A group of greatly altered and very anci nt rocks hich m greatly devel ped along the course of the St. Laurence wh nce the name. It is in thes that the earl e t known traces of or gan c bodies have been found

Leguminosæ, An order of plants repre ented by th common peas and beans, having an irr gular flower in which on p tal sta ds up like a wing and the stamens and pistil are encl sed in a sheath formed by two other petals The fruit is a pod (or legum)

Lemuridæ, A group of four ha d d an m ls dis t ct from the monk ys and pproaching the in sect orous quadrupeds in some of the r char acters and habits Its members l a the n strils curved r twisted and a cl w inste d of a na l upon the first finger f the h nd hands

Lepidoptera An order f insects ch r ct rised by the p ssess on of a sp ral prob c s, a d of f ur large mo e r l ss caly wings It includ s the well known butterfli s a d m ths

Littoral, Inhabiting the seashore

Loess A m rly dep sit of recent (Post Tertiary) date wh ch occup es a gre t part of the valley of the Rhine

Malacostraca Th h gh r di is on f the Crustacea, incl ding the ord n ry cr bs, l b ters, hr mps, &c. t gethe w th the oodl ce d sa d h ppers

Mammalia Th h ghe t class f an m ls, lud ng

f om the t at (*M mmæ M mma y gl nds*) f the m ther A strik g d ff renc in mbryon c d el pm t has led to the d n f this cla s to

ng a d the y ng p od ed n a ry incom pl te tate The form clud g th g e t p t f the cl ss re called *Place t l m mals* the latt r or *Aplacental m mmal* l d the mar upi ls nd m n tremes (O n thorhynchus)

Mammiferous, H v g mammæ teats (*ee* **Mammalia**)

Mandibles, in n ects, the firs r upp rm t p r f jaws, wh ch a g n rally sol l li r y b ti g org ns In b rds th term is ppl ed t botl j s with th ir horny cov rings. In quadruped the mandible is properly th lower j w

Marsupials, An rd r of Mammalia in hich the young are born in a very compl te tate of de v lopment, nd carried by the moth r whil sucki g in a ve itral pouch (marsup um) such as the kangaroos, opossums, &c. (*s e* **Mammali**)

Maxillæ, in insect the *second or l er p r of* jaws, wh ch are comp sed of se ral j nts a d furn ish l with peculiar jo t d append ges called palp r feelers.

Melanism The oppos te of albinism an u due de vel pment of colouring material in the skin and its appendag s.

Metamorphic Rocks, Sedimenta y rocks which have undergone alterat gener lly by the ct of heat sub eque tly to th ir deposit a d con-

known und r the der ominat on f hellfish the cuttle-fi h and the c mmon *s a ls*, h lls, oysters, muss ls, and cockles, m y serve as ex ampl s of th m

Monocotyledons r **Monocotyledonous** l **a** **ts**, l l nts in wh h th eed ends up o ly a ngl seed l af (r cotyledon) hara teri ed by the b sence of c secuti e l y s f ood in th st m (dogen us gr wth) by th ns f the l a es bei g g rally stra ght, and by th p rts f the flowers b ing g ner lly mult ple f three (*E mple* gra ses l l es, ch ls, p lms, &c.)

Moraines, Th accumulat ons of fragme ts of rock br ught d wn by glac rs

Morphology Tl la of f rm or stru ture i de per de t of fu ct

Mysis-sta e, A stag in the d l pm nt of certa n cru tac s (prawn) in l l they cl sely resembl th dults f a g us (*My*) *belonging to* a l ghtly lo r group

Nascent Comme ing d vel pment

Natatory Adapted for the purpo e f s im n g

Nauplius-form Th earl t st ge tl d l p n t of many Crust a, pec lly bel g g t the l er group I n th tag the n m l has a h t l od w th l t d t ns f a d

cl ps was d scr bed s a dist t g n me of Naupl us

Neuration Th arra g m t of th ve ns r ner ur s i tl w g f i ect

Neuters, Impe fectly d l ped f al s f c rta n soci l *i se ts* (*ucl as ts d bees*) h h per f m ll the labours of th commu ty H ce th y lso called *worker*

Nictitating Membrane, A sem tra sparent m m li wh l can be dra cross th y i b *rds* and reptiles, th r to mod r t th ffects of a

strongl ht or t weep particles of dust, &c., from the urface of the eye

OCELLI. The simple eyes or temmata of insects, usualy tuated the crown of the head between the great compound yes.

ŒSOPHA US. Th gullet.

OOLITIC A gre t series of secondary rocks, so called from the texture of som of its members, hich ppear to be made p of mass of small gg-lik calcareous bodies.

OPERCULUM. A calcareous plat mployed by many Mollusca t close the perture of their shell. The percular valve of cirripedes are those which close the perture of the shell.

ORBIT The bo y ca ity for th recептio of th eye.

ORGANISM. A organised being, whether plant or animal.

ORTHOSPERMOUS. A term pplied t those fruits of the Umbelliferæ hich ha the seed straight.

OSCULANT Forms gro ps ppare tly int rmediate between and connecting othe gro ps are said to be osculant.

OVA. Eggs.

OV RIUM or OVARY (plants) Th lower part of the pistil or female organ of the fl wer co taining the vules or incip t seeds by growth after the other organs of th fl w have fallen, t usually becomes co rted int th fruit.

OVI EROUS. Egg-bearing.

OVULES (of plants) The seeds in the earliest condition.

P CHYDERMS. A group of Mammalia, so called from their thick skins, nd including the elephant, hinoceros, hippopotamus, &c.

P LEOZOIC. The oldest syst m of fossiliferous rocks.

P LPI. Jointed ppendages to som of the organs of the mouth in insects nd Crustacea.

PAPILI EÆ. A order of plants (see LEGUMI OSÆ). The fl ers of these plants are called papilionaceous, or butterfly lik from th fancied resembla ce of th xpanded superio petals to the wi gs of tterfly

PARASITE. An imal or pla t living po or in, and t th pense of th rganism

 RTHENOGENESIS. The product of living organisms from nimpregnated ggs or seeds.

PEDUNCULA ED. pported po stem or stalk. Th pedunculated oak has ts acorns born po footstool.

PELORIA or PELORISM. Th ppearance of regularity structure in the flowers of plants which normally bear irregular flow rs.

PELVIS. Th bo y arch t hich the hi d limbs of ert b ate nimals are articulated.

PETALS. The leaves of the corolla, or second ircle of org ns in flow They are usuall of d licat t ture nd brightly col ured.

PHYLLOD OUS. Havi g flatt ned, leaf lik twigs or leafstalks instead of true lea es.

PIGMENT Th colouring material produced generally in th uperficial parts of nimals. The cells secreting are called pigment-cells

PI TE. Bearing leafl ts ach nd of central stalk.

PISTILS. Th f male organs of wer which occupy positio in th ce tre of th ther floral organs. Th pistil is generally di isible int the ary germ n, th tyle and the stigma.

PLACENT LIA. PLA ENT A, or Place tal Mammals. See MAMMALIA.

PLA TI RA ES. Quadrupeds which walk upo the whole sole of th foot, like the bears.

PLASTIC. Readily capable of change.

PLEISTOCEN I riod. The latest portion of the Tertiary poch.

PLUMULE (plants). The mi ut bud betwee the seed-lea es of newly germinated plants.

PLUTO. C ROCKS. Rocks pposed t have bee produced by gneous actio in th d pths of the earth.

POLLEN Th male eleme t in flowering plants usually fine dust produced by th anthers, which, by co tact th the stigma ffects the fecundatio of the seeds. This impregnatio is brought about by means of tubes (pollen-t be) which issu from the pollen-grains adhering t the stigma, and penetrate through the tissues until they reach the rary

P A DROUS (flowers). Flowers ha ing ma y stamens.

POLYGAMOUS PLANTS. Plants in which som flowers are unisexual and others hermaphrodite. The nisexual (male and f male) flo ers, may be the sam or on differe t plants.

P MORPH C. Prese ting many forms.

P YZO The comm tructure formed by the cells of the Polyzoa, uch as the w ll-known seamats.

PREHENSILE. C pable of grasping.

PREPOTENT Ha ing periority of power

PRIMARIES. The feathers formi g the tip of the wing of bird, and nserted upo that part which represe t the hand of man.

PROCESSES. Projecti g portions of bones, usually for the ttachm t of muscles, ligame ts, &c.

PROPOLIS. A resinous material collected by the hive-bees from th pe ing buds of arious trees.

PROTEAN Exceedi gly ariable.

PROTOZOA. Th lowest gre t di isio of the nimal kingdom. These nimals are composed of g lat inous material, nd show scarcely any trace of distinct organs. Th Infusoria, Foraminifera, nd spo ges, with som other forms, belo g to this di ision.

PUP (pl. PU Æ) The seco d stage in th development of nsect, from which t merges in th perfect (winged) reproduct ve form. I most insects th pupal stag is passed in perfect repose The hrysalis is the p pal tat of butterflies.

RAD CLE. The mi ute root of an embry plant.

RAMUS. O half of th l wer j w in th Mammalia.

The portion which rises to articulate with the skull is called the *ascend ng r m s*

RANGE, The ext nt of country over which a plant or animal is naturally spread *R nge in t me* expr sses the d stribution of a species or gr up through the fos l ferous beds of the earth s cru t

RETINA The del cate inn r coat of the eye formed by nervous filaments spread ng from the optic nerve and serving for the perc ption of the im pre s ons produced by l ght

RETROGRESSION Backward development When an animal as it approaches maturity becomes less perfectly org nised than might b e p cted fr m its early stages and known relationships it is said to undergo a *retrog de d velopment* or *meta or phosi*

RHIZOPODS A class of lowly organised animals (Protozoa) having a gelatinous b dy the surface of which c n be pr truded in the form f root l ke pr c sse or filaments which se ve for l comotion and the prehension of food The m st i portant rder i that of the Foramin fera

RODENTS Th gnaw ng Mammalia such as the ts bbits and squirrels They are especially ch ract rised by the p ssession of a single pair of ch el like cutting t eth in each jaw betwe n which and the gr nd ng teeth th re s a gr at g p

RUBUS The bramble g nus

RUDIMENT RY Very mp rfectly devel ped

RUMINANTS The gr up of qu d upeds which ru minat r chew th cud such as oxen sheep and d They have d vid d h fs and are destitute of fro it teeth in the upper jaw

SACRAL, B l nging t the sacrum or the bone com p ed u u lly of two more unit d vertebræ to l ch th d s of th pelvis in v rtebrate animals e attacl ed

SARCODE Tl gelatin us mat r al f which the bodies of the low t nim ls (Prot zoa) re comp sed

SCUTELLÆ, The horny pl tes ith h h the fe t of b ds ar g rerally m re or less covered pe c lly n fro t

SEDIMENT RY FORMATIONS, Rocks depos ted as sed iments f m wat

SEGMENTS, Th tr ns erse ri gs of wh ch th body of a i a ticul t at m l or ann l d comp ed

SEPALS Th l es r gme its of the c lyx r ut rm t e velop of n rd n ry flo r Th y re u u lly g ee i b t omet m br ghtly col ured

SERRATURES Te th l ke th e f saw

SESSILE, N t s pp t d on a t m r footstalk

SILURIAN SYSTEM V ry nc e it ystem f foss l f ro rocks belong g to th e rh part of the P læo o c r es

SPECIALISATION The s tt g p rt f a particul r g n f r tl e perf rm nce f a p t ular f ct on.

SPINAL COR Th ce t l p rt n of th n rv us sy t m i th V rt l rat wl h d sc nds f m th bra i thro gh tl e rcl e f tl t l r d gi s off i rly all th i rv s to th v us g ns of the body

STAMENS Tl male organs of flowering plants, st ndi g in a circle with n the petals. They usu ally con ist of a fil ment nd an anther the nth r being tl e essent al part in which the pollen fecundating dust is formed

STERNUM Th br ast bone

STIGMA Tl e apical portion of the p t l i flo ering pl nts

ase of

fect pistil,
y nd sup-

n.

ction of the

TARSUS (pl TARSI) Th

et n usually
ny
y rg ns l

n or touch

TRACHEA Tl e windp pe or passage for th admis s n f ir t the lungs

TRIDACTYLE Th ee-fing ed r c mpo ed of three movable part tt l ed t a c mmon ba

TRILOBITES A p ul group f t crust ce h t r mbl g th oodl ce in x ternal f rm nd lik s m f tl c p bl f roll ng tl m elve up i to ball Th rem ns ar f u l ly in th P læo o c rocks, a d most bundantly in th e of S l n ag

TRIMORPHIC P ntu g th e d st nct forms

UMBELLIFERÆ An d f pla its n h tl fl s, h h cont in fiv tamens nd pi til with two tyle upp rted up n footst lks h h pring from the t p f th fl r tem d sp nd out l k th w r s of n umbr ll o as to b g all the fl r n th s m he d (*mbel*) ne ly t the same l el (*Examples* parsl y d carrot)

UNGULAT Hoof d quad up ds

UNICELLULAR C ns t g f a ngle cell

bræ wh l co ist tut s th ce tr f tl e sk l t nd t tl sam t m p t d protect th centr l p rts f the rvous y t m

WHORLS. The circles or spiral lines in which the parts of plants are arranged upon the axis of growth.

WORKERS. See neuters.

ZOEA-STAGE. The earliest stage in the development of many of the higher Crustacea, so called from the name of Zoea applied to these young animals when they were supposed to constitute a peculiar genus.

ZOOIDS. In many of the lower animals (such as the corals, Medusæ, &c.) reproduction takes place in two ways, namely, by means of eggs and by a process of budding with or without separation from the parent of the product of the latter, which is often very different from that of the egg. The individuality of the species is represented by the whole of the form produced between two sexual reproductions; and these forms, which are apparently individual animals, have been called *zooids*.

THE DESCENT OF MAN

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CHAPTER XXI

INTRODUCTION

THE NATURE of the following w rk will be best understood by a bri f account of h w t cam to be written. D ring man ars I col lected notes n th rigin descent f man, with t any inte ti n f p bli l n th subject, but rath with the d term ti n n t to p blish, as I th ght th t I sho ld thus nly add to th prej d ce gainst my i ws. It seemed to me suffici t to d cat in the first edition of my *Origin f Specie* that by this w k "light w uld be thrown n th rigin f man and his histo and this implies that man must be incl ded w th th ganic beings in any ge ral con lusi n re pect g his mann of ppearance n th arth N w the case w ars wh lly d ff re t a pect. When turalis t lik Carl V t t re to say in his address as Presid nt f th N tional Instit tion f G n (1869) *pe ne en Europe moins os plus te ir la cré ation ndépend nte et d t utes pece d espece* t is manif t that t l ast a large umbe of naturalists must admit that species are th modified descend t f th pe s and thus especiall h ld good w th th

attention may be directed but these great classe of facts afford as it ppears to m ample and conclu v e id nce in f ou of th principl of gradual ev l ti n Th trong pport d ri ed from the th r argum nts should h we r al ay be kept before the mind

Th sole bject f this wo k is to consid r firstly wh th r man, l ke e ry th r pecies, is descended from some pre-e ting f rm secondly th manner of his d lopment and thirdly th al f th d ff rences between the so-called race of man. As I sh all confin myself to these po nts, t w ll n t be necessary to d scribe in d tail the d ff re ces between the se ral races—an rm us ubject wh ch has be n full d scussed many al abl w ks. Th l gh ant quity of man has recently been d m nstrated by th labours f h st f m ent m beginni g w th M Bo che de P rthes and this is the ind pe sable bas s f und rstanding hi rigin. I shall, th re f re take this conclus fo granted and m y ref my read rs t th adm rabl tre tises of S Charles L ll, S J hn Lubbock, and th rs. N I ll I h occas on t d m re th an t allud to the am u t f

tunat ly are till pposed t l ti m ry f rm

In conseq nce f th w n w ad pted by most naturalists, and wh h w ll ult m t ly as in ry th case be f ll wed b th rs wh are t sci tific, I h bee led t p t together my notes, so as t see h w far th g ral co lusi ns arri ed t m f rm w ks w re pplicabl to man This seemed all th more desirabl as I h d d liberat ly pplied these w t pecies tak n sin ly Wh w confin tt t n t an f rm, w are d pri ed f th w ght arguments deri ed from th n t re f th affinities whi h connect t g th wh l gro p f ganisms—their geographical d trib t n in past and prese t times, and th ir geol gical cess Th h mological tru t re, mbryological d l pm nt, and rud m ntary ans of species remain t be considered wh th t be man any th animal, to which ur

f prim t

This w k contains hardl any rigi al facts in reg whi ll draft, th t th

and co fid ntly been asserted th t man rigin can n be known b i gnorance m re freq tly beg t confid ce than does kn wl edge t th se wh kn w littl and t th se wh kn w much wh so posit l assert that this th t probl m w ll n be sol ed by sci ce Th co cl th t man is th co-d sce d t with oth pec f som anci t, l w and xt nct f rm n t n any d gree n w Lamarck l g g cam to this con l n, whi h has lat l been mai tained by se al mi n t naturalists and phil soph rs f nstance, by Wallace, Huxl y L ll, V gt,

Lubbock Büchner Rolle &c [1] and e pecially by Haeckel This last naturalist besides his great work *Generelle Morphologie* (1866) has recently (1868 with a second edit in 1870) published his *Naturliche Schopfungsgeschichte* in which he fully discusses the genealogy of man If this work had appeared before my essay had been written I should probably never have completed it Almost all the conclusions at which I have arrived I find confirmed by this naturalist whose knowledge on many points is much fuller than mine Wherever I have added any fact or view from Prof Haeckel s writings I give his authority in the text other statements I leave as they originally stood in my manuscript occasionally giving in the foot notes references to his works as a confirmation of the more doubtful or interesting points

During many years it has seemed to me highly probable that sexual selection has played an important part in differentiatin the races of man but in my *Origin of Species* (this edition p 43) I contented myself by merely alluding to this belief When I came to apply this view to man I found it indispensable to treat the whole subject in full detail [2] Consequently the second part of the present work treating of sexual selection has extended to an inordinate length compared with the first part but this could not be avoided

I had intended adding to the present volumes an essay on the expression of the various emotions by man and the lower animals My attention was called to this subject many years ago by Sir Charles Bell s admirable work This illustrious anatomist maintains that man is endowed with certain muscles solely for the sake of expressing his emotions. As this view is obviously opposed to the belief that man is descended from some other and lower form it was necessary for me to consider it. I likewise wished to ascertain how far the emotions are expressed in the same manner by the different

published by Dr Francesco B rrag bear g in Ital n the t tl of Man m de in th im ge of God was also made n the im ge of the ape

works.

Part One

Descent or Origin of Man

CHAPTER I

THE EVIDENCE OF THE DESCENT OF MAN FROM SOME LOWER FORM

ti ns are ...

ance w th the law wh h p ail w t t lowe anim ls. Again, are th ar ti n the res lt, as f as gn ance permits u to j dg f th m g l causes, and ar th y g rned by th same g n al f ws, as n th case f th gai ms f t nce by corre l.ti n, th inh rited ffects f se and dis se, &c.? Is man subject to milar m lconf rma- ti ns, th esult f arre ted d l pm t f red pl cati n f parts, &c. and does h d play m l e n to som f

f r a t m and we will first see l w far tl e bod ly tru ture f man sh ws traces, m e r less plain, f h s descent from some l w r f rm In ucceed ng chapt rs th me tal pow rs of man n comparison w tl those of the low r animals, w ll b cons dered

The Bodily Struct e f Man It is notori tri t d on th same g n

co ...

So it w th his muscles, ne es, b ... and int rn l scera. The b ain the most im portant f all the gans, f ll ws the same law as sh wn by Huxl y and oth e anat mists B sch ff who s a h til w tn ss, admits that y chi f fis ure and f ld in th bra n of man has ts analogy in th t f th ang b t h nerod f d l pm nt do

t

— —

Th quire w uld t com to t ... so tant point, wh th man tends t ase at so pid te, as to l ad to occas nal se re truggles f ex t ce and conseq tly to be ficial ar t wh th body o mind being p ese ed and injuri us es l m nated D th ac pect f m n, wh l t rm m v b ppl ed n ach n and place an tl so th t som fi ally becom t t? W sh ll see th t all th se q ti s, as deed h m re pect t most f th m m t be answ ed th af firm t e, in th sam mann as with th l animals. B t th se al co d tions just ref red to may be con m tly defer ed

ent t ... ...

perieu nt bien m mes Il ne f t pas e f d'ill ne à et ég d L hom ... est bien pl pr e des gee nth pomorph pa les ca acter nat m ques d err q e ce -e ne le st lem nt des au s m mm f es mais mem de ert m g adru

th h gh mammals ... b ain and all th part f th body

G k enmend gen d Mens hen, 1868 s. 96 Th co clus ns of this th as ll as thos f Grati let d A by co cerni g th bra will be d scussed by Prof Huxley th ppe dix pag 360

Leç su la Phy 1866 p 890 as q ted by M. Dally L Ord des Primate et ... T form sme, 1868, p. 29

a
d
by which the ... correspondence

... lower animals, and to communicate to them certain diseases, as hydrophobia, variola, the glanders, syphilis, cholera, herpes, &c.;[3] and this fact proves the close similarity[4] of their tissues and blood, both in minute structure and composition, far more plainly than does their comparison under the best microscope, or by the aid of the best chemical analysis. Monkeys are liable to many of the same non-contagious diseases as we are; thus Rengger,[5] who carefully observed for a long time the *Cebus azaræ* in its native land, found it liable to catarrh, with the usual symptoms ...

... and cataract in the eye. The younger ones when shedding their milk-teeth often died from fever. Medicines produced the same effect on them as on us. Many kinds of monkeys have a strong taste for tea, coffee, and spirituous liquors: they will also, as I have myself seen, smoke tobacco with pleasure.[6] Brehm asserts that the natives of north-eastern Africa catch the wild baboons by exposing vessels with strong beer, by which they are made drunk. He has seen some of these animals, which he kept in confinement, in this state; and he gives a laughable account of their behaviour and strange grimaces. On the following morning they were very cross and dismal; they held their aching heads with both hands, and wore a most pitiable expression: when beer or wine was offered them, they turned away with disgust, but relished the juice of lemons.[7] An ...

... these trifling ...

... affected.

Man is infested with internal parasites, sometimes causing fatal effects; and is plagued by external parasites, all of which belong to the same genera or families as those infesting other mammals, and in the case of scabies to the same species.[8] Man is subject, like other mammals, birds, and even insects,[9] to that mysterious law, which causes certain normal processes, such as gestation, as well as the maturation and duration of various diseases, to follow lunar periods ...

... especially during an early embryonic period, occasionally possess some power of regeneration, as in the lowest animals.[10]

The whole process of that most important function ... species is ... from the ... the birth ... young Monkeys are born in almost as helpless a condition as our own infants; and in certain genera the young differ

Dr. W. Lauder Lindsay has treated this subject at some length in the *Journal of Mental Science*, July 1871; and in the *Edinburgh Veterinary Review*, July 1858.

... o ... ct fluids by the same chemical reagent.

'Naturgeschichte der Säugethiere von Paraguay,' 1830, s. 50.

The same tastes are common to some animals much lower in the scale. Mr. A. Nicols informs me that he kept in Queensland, in Australia, three individuals of the *Phascolarctus cinereus*; and that, without having been taught in any way, they acquired a strong taste for rum, and for smoking tobacco.

Brehm, *Illustrirtes Thierleben*, B. i. 1864, s. 50. On the ... 105. For other analogous statements, see ... ss. 25, 107.

Dr. W. Lauder Lindsay, *Edinburgh Veterinary Review*, July 1858, p. 13.

With respect to insects, see Dr. Laycock, 'On a General Law of Vital Periodicity,' *British Association*, ... North Am... 05 has re... ll ... b... d ... y ... *nacr Dom tic* ... could be added.

M... d... n... g... erib... Quad... a... m... n... d... b... d... gn... u... f...

... *is m... p... obaest... t... alor... ej... dem loci... et... l... m... t... fi... m... it... S... t... d... w... Smith... et... B... hm not bant id m... Cynocephalo... Illust... m... (... ier... t... t... m... ll... de... ha... q... d... t... pano... hil... t... p... pot... st... nd... re... nter... om... hom... Il... t... Q... d... m... is... communis... Nrat... m... Cynocephal... m... q... end... m... n... f... orem... neuter... p... t... f... m... m... l... q... em... d... nequaq... m... c... id... ta... d... f... ore... h... om... b... S... mper... l... g... bat... j... or... t... d... gno... c... bat... t... bd... t... odroc... bat... coc... gest... q*

full as much in ppearance from th ad lts, as do our children from th ir f ll grow par ents. It has been urged by so n writ rs, as an important distinct n, th t w tl man the oung arri at maturit t a much l t age than with an th animal but if w look to the races of manki d which inhab t tropical co ora fro wo as

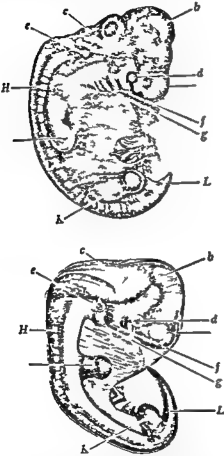

Fig 1 Uppe figure huma mbryo, from Ecker Low figure that of d g from Bischoff

a. F re-brain, ce bral hem pheres, &c b. Mid-brain, corpora quadrigemina Hind-brain, cerebellum, medula oblo gata d. Eye Ear f First visceral arch g Second visceral arch H V rtebral columns and muscle in process of developme t Anterior tremities K Posterior tremities L. T il os coccyx

the two se es f man mammals. So that the corre po d nce g n ral tructure in the min t tructure of th tissues, n chem cal composition and in constit t n, between man and th high mammals, especially the anthro- l ml ne s xtrem l l se

ry arly period can ...

from that of th m mbers of th rt brat l l m At th period th art ries run in

f rm positi n. At somewh t l t period wh n th tremities are d l ped, th feet f lizards and mammals, as th llustri us n Bae remarks, th wings and feet of b rds, n less than th hand and feet of man, all arise from th same fundam ntal f rm. It is, say Prof Huxl quite in th lat r tages f d l pm nt that th young human being prese ts marked diff rence from th ung pe, whil th latt departs as m ch from th d g in ts d lopm nts, as th man does. Startling as this la t asserti n m y ppear t be t d m nstrably tru "

As som f my read rs m n r ha seen a drawi g f an mbryo, I h g n on of man and anoth f d g, t abo t th sam arl tag f d lopment, caref lly cop ed from two w ks of nd bted accu acy.[15]

Aft th f rego g tat m nts mad by uch high th rities, I w uld be perfl s o m part to gi a numbe f borrowed d tails,

[13] This remark is made th respect t Cynocephalus nd the anthropomorph us pes by Geoffroy Saint Hilaire and F C vier Histoir Nat de M m feres, tom. i., 1824

Huxley M Plac in Nat 1863, p. 34

M Plac Nat 1863, p. 67

[15] The human mbry (pper fig) is from Eck Icones Phy 1851 1859 tab. xxx. fig 2. This mbry was t lines l gth, so that th dra g is much magnified. The embry f the d g is from Bischoff Entw H g g schichte de H nd Fie 1845, tab. xi., fig 42 B. This drawing is fi times magnified, th embry being tw ty fi e days old. The internal viscera have bee omitted, nd th terine ppendages in both drawi gs remo ed. I was directed t these figures b Prof Huxley from whose work, M Place Nat the idea of gi ng them was taken. Haeck l has also gi n analogous dra ings in his Schopf g geschichte.

shewing that the embryo of man closely resembles that of other mammals It may however be added that the human embryo likewise resembles certain low forms when adult in various points of structure For instance the heart at first exists as a simple pulsating vessel the excreta are voided through a cloacal passage and the os coccyx projects like a true tail extending considerably beyond the rudimentary legs [16] In the embryos of all air breathing vertebrates certain glands called the corpora Wolffiana correspond with and act like the kidneys of mature fishes [17] Even at a later embryonic period some striking resemblances between man and the lower animals may be observed Bischoff says that the convolutions of the brain in a human fœtus at the end of the seventh month reach about the same stage of development as in a baboon when adult [18] The great toe as Professor Owen remarks [19] which forms the fulcrum when standing or walking is perhaps the most characteristic peculiarity in the human structure but in an embryo about an inch in length Prof Wyman[20] found that the great toe was shorter than the others and instead of being parallel to them projected at an angle from the side of the foot thus corresponding with the permanent condition of this part in the Quadrumana I will conclude with a quotation from Huxley [21] who after asking does man originate in a different way from a dog bird frog or fish says The reply is not doubtful for a moment without question the mode of origin and the early stages of the development of man are identical with those of the animals immediately below him in the scale without a doubt in these respects he is far nearer to apes than the apes are to the dog

Rudiments This subject though not intrinsically more important than the two last, will for several reasons be treated here more fully [22] Not one of the higher animals can be named which does not bear some part in a rudimentary condition and man forms no exception to the rule Rudimentary organs must be distinguished from those that are nascent though in some cases the distinction is not easy The former are either absolutely useless such as the mammæ of male quadrupeds or the incisor teeth of ruminants which never cut through the gums or they are of such slight service to their present possessor that we can hardly suppose that they were developed under the conditions which now exist Organs in this latter state are not strictly rudimentary but they are tending in this direction Nascent organs on the other hand though not fully developed are of high service to their possessors and are capable of further development Rudimentary organs are eminently variable and this is partly intelligible as they are useless or nearly useless and consequently are no longer subjected to natural selection They often become wholly suppressed When this occurs they are nevertheless liable to occasional reappearance through reversion—a circumstance well worthy of attention

The chief agents in causing organs to become rudimentary seem to have been disuse at that period of life when the organ is chiefly used (and this is generally during maturity) and also inheritance at a corresponding period of life The term disuse does not relate merely to the lessened action of muscles but includes a diminished flow of blood to a part or organ, from being subjected to fewer alternations of pressure or from becoming in any way less habitually active Rudiments however may occur in one sex of those parts which are normally present in the other sex and such rudiments as we shall hereafter see have often originated in a way distinct from those here referred to In some cases organs have been reduced by means of natural selection from having become injurious to the species under changed habits of life The process of reduction has done all that can fairly be attributed to it, and when the saving to be effected by the economy of growth would be very small [23] are difficult to understand The final and complete suppression of a part already useless and much

[20] of Wyman in P c ed gs f th Americ Academy f Sciences vol iv 1860 p 17

[19] O Anatomy of V rt brates v l i p 533

[21] Die G os h rnwind gen des M nschen, 1868

his Gener lle Morphologie

[23] Some good criticisms on this subject have been g by Messrs. Murie and Mivart in Transactions Zoologic l Society 1869 vol vii p 92.

ed ced in size, n which case neithe compen at o eco my can com int pl y t pe h d f th hypoth si of

R dim ts f ari us muscle ha e bee ob rved m y parts f the human body [26]

th now wh h many animals, especially

bodies f r instance th m scl th f re h ad by whi h th ey brow ar a sed Th *plat ma my ides* wh ch s w ll d l ped n th eck, belo g to thi y tem Prof Turn f

i tan t f th *et bd m al* b t i losely all ed to tl pa *sculus* occ rred th proport f b t three pe ce t up- ward f 000 bod h adds, th t th muscl af f rd an cell t ll t ti n f tl t t m nt th t occasi l and rud m tary tru t re are peci ll l bl t ri ti rang m t.

Som f w pe so th pow f con tracting th pe ficial muscl th scalp and th se m scl ri bl and par t lly rudim tary nd ti n. M A. d Cand ll has commun ted t m n nstance f th l g-co ti ed pe t ce h rstance f th pow as w ll as f t un ld l p- m t ll h famil wh ch o m m b th p se t head f tl f mily co ld wh th p tch se al h vy books from

hi head by th movement f the scalp al ne and he won wag rs by perform g this f at. Hi f th r u cl grandfath r and h tl ree cl ll r n possess the sam powe to the sam un s al d gree Tl is f mily became d ded t r i to tw b anches so

prog n tors since m y m k ys na anu freq ently use the powe f *largely mo i g* the scalps up and do n.[27]

The t ns c muscle wh h serv to m ve

rnal l m d el pm t at least in f ne

p

ars and thus di ecti g o tt nt n to- w d th m co ld reco r som power f m m nt by r peated trials. The po er f recti g and directi g the sh ll f th ars to th ar us points f the compass, is no d bt

m y be consi l red ru l m t, togetl w th th f ld nd promin n (h l and anti l l t agu and anti tr gu &) wh h i tl e l w anim l l gth n and s pport th ar wh rect, w tl t add g m h to ts w ght Som th s, howe s ppose tl t th carti lag f the sh ll serves to t an m t vibrati s to th aco ti n b t Mr T ynbee [28]

i ratio *f Animals and Plants nder D mest*

Prof W Tur *Proc ed ng f the Royal Society of Ed nbu gh*, 1866-67 p. 65

[26] See my *E pressi f the Emotions M nd A mal* 1872, p 144

[27] Can trini q t Hyrtl. (*A uario dell Soc dei N t alisti*, Mod na 1897 97) t the sam effect.

[28] *The Diseases f the E* by J T ynbee F R S 1860 12 A distinguished phy l gist, Prof P y inf rms m that h had lat ly bee peri- m ting th fun ti f th h ll f th nd has com to early the sam co lusi as that gi h re.

after collecting all the known evidence on this head concludes that the external shell is of no distinct use The ears of the chimpanzee and orang are curiously like those of man and the proper muscles are likewise but very slightly developed [20] I am also assured by the keepers in the Zoological Gardens that these animals never move or erect their ears so that they are in an equally rudimentary condition with those of man as far as function is concerned Why these animals as well as the progenitors of man should have lost the power of erecting their ears we can not say It may be though I am not satified with this view that owing to their arboreal habits and great strength they were but little exposed to danger and so during

... to that of those large and heavy birds which from inhabiting oceanic islands have not been exposed to the

... an move the head in a horizontal plane so as to catch sounds from all directions It has been asserted that the ear of man alone possesses a lobule but a rudiment of it is found in the gorilla [21] and as I hear from Prof Preyer it is not rarely absent in the negro

The celebrated sculptor Mr Woolner informs me of one little peculiarity in the external ear which he has often observed both in men and women and of which he perceived the full significance His attention was first called to the subject whilst at work on his figure of Puck to which he had given pointed ears He was thus led to examine the ears of various monkeys and subsequently more carefully those of man The peculiarity consists in a littl ... he in ... esent, ... Prof Ludwig Meyer more frequently in man than in woman Mr Woolner made an exact model of one such case and sent me the accompanying drawing (fig 2) These points not only project inwards towards the c ...

rectly in front or behind They are variable in size and somewhat in position standing either a little higher or lower and they sometimes occur on one ear and not on the other They are not confined to mankind for I observed a case in one of the spider monkeys (*Ateles beelzebuth*) in our Zoological Gardens and Mr E Ray Lankester informs me of another case in a chimpanzee in the gardens at Hamburg The helix obviously consists of the extreme margin of the ear folded inwards and this folding appears to be in some manner connected with the whole external ear being permanently pressed backwards In n

Fig 2 Human Ear modelled and drawn by Mr Woolner
a. The projecting point

the ear is slightly pointed and the margin is not at all folded inwards but if the margin were to be thus folded a slight point would necessarily project inwards towards the centre and probably a little outwards from the plane of the ear and this I believe to be their origin in many cases On the other hand Prof L Meyer in an able paper recently published [22] maintains that the whole case is one of mere variability and that the projections are not real ones, but are due to the internal cartilage on each side of the points not ...

... minute points or the whole margin is sinuous I have myself seen through the kindness of Dr L Down the ear of a micro-

[20] Prof A Macalister *Annals and Magazine of Natural History* vol ... 1871 p 342.
[21] Mr St George Mivart, *Elementary Anatomy* 1873 p 396

[22] See Lo ... m rk ... d the drawings ... the ears of the Lem r ... Messrs Muri ... d Mivart ... Transactions of the Zoological Society ... 1869 pp 6 ... d 90
[23] Über das Darwin'sch ... pitzoh ... *Archiv für Path Anat* ... 1871 p 485

cephalous idiot, n wh ch th re is a projecti on the outsid of the h lix and n t n th inward folded edge, so th t this point can ha e n t f rm pex f th ear Ne rthe-

to be mad p

of th cartila through t the wh le xt nt f the margin, t w uld ha e co red fully e- third of th wh l ar Tw case h been communicated to m on in N rth Am rica, and the the in England n which th ppe margin is t t all f lded wards, b t pointed, so that t l sely resembles th po ted ear of an rdinary q adruped n o th In ne of these cases, which was that f y ung child, th f th compared th ar with th drawing which I h n[24] f th ar of a m nkey th *Cynopithec* g and sa tl t th ir tlines are cl sel similar If th se two cases, th margi had been f lded wards in th rmal mann an nw rd project n must ha e bee f rmed. I m y add that n tw th cases th tlin till remains som what pointed, altho gh th margin f th ppe part of th ar is n rmall f lded inward —in of them, how narrowly Th f l lowing woodcut (fi 3) . an accurate copy of photograph f th fœtus f an rang (kindly se t m by D N tsch) in which t may be seen h w diff re t t is pointed tlin of th ear t this period from ts adult cond ti n, wh t bears a close g n ral resemblance to that f man. It is d t th t th f lding er of th tip of ch an ar unless t changed greatl during ts furth d l pm t, w uld give rise to poi t projecting inwards. On th wh le, t till seems to m probabl that th po ts in q esti are in som cases, both in man and pes, estig f f rm co dit n

Th nictitating membrane, third lid, th ts accessory muscl and th tru tures, especiall w ll d loped in b rds, and is of m h f ncti al importance to th m, as t can be pidly drawn across th wh l ball H f und in som reptil and amphib- ans, and in ce tain fishes, as in sharks. It fairly w ll d loped in th tw l w di si ns f th mammal an series namely in tl e Mo o- trem t and mars p als, and n some few of H h gl mamm ls, as in the walrus. But i man, tl Quadrumana, a d mo t tl mam mals, t xi ts, as i adm tted b all anat mi ts, as a m re rud m t, alled th semi l r f ld[25]

The sense f m ll s f th high t mportance t the gre t r umber f mammals—to some as th ruminants, in warning tl m f dan er to oth rs, as the Carn ra, in findi g th prey to th rs, gain, as th wild boar f both purpose comb ed B t the sense f m ll is f extremely slight serv ce if an e n to the dark col ured races f men, n wh m it is much more highly d l ped than in th white and civilised races.[26] N rth less t

Fig 3 Fœtus of orang Exact copy of phot graph, sh g th f rm of th ear t this arly ge.

The Expressio of the Emotions, p. 136.

K. K s, *G eat Art sts nd A atomists* p 106 Th rudim t ppare tly is som hat large N groes nd Australians tha in Europeans, see Carl V gt,

perm ts, nd pro ed that N groes nd Indians could recognise persons in th dark by their od ur D W Ogle has mad som curi us bserv tions the connect betwee th pow of sm ll nd th col uring in tt of th m cous m mbra of th lfactory re as w ll as f th kin f th body I ha e, therefore poke in the text of th da k col ured races ha ing fine sense of m ll tha the white races. See his pape *Medico-Ch gical Transactions* Lond n, 1 lui., 18 0 p. 276

does not warn them of danger nor guide them to their food nor does it prevent the Esquimaux from sleeping in the most fetid atmosphere nor many savages from eating half putrid meat. In Europeans the power differs greatly in different individuals as I am assured by an eminent naturalist who possesses this sense highly developed and who has attended to the subject Those who believe in the principle of gradual evolution will not readily admit that the sense of smell in its present state was originally acquired by man as he now exists He inherits the power in an enfeebled and so far

animals which have this sense highly developed such as dogs and horses the recollection of persons and of places is strongly associated with their odour and we can thus perhaps understand how it is as Dr Maudsley has truly remarked[37] that the sense of smell in man is singularly effective in recalling vividly the ideas and images of forgotten scenes and places

Man differs conspicuously from all the other

that of a woman The different races differ much in hairiness and in the individuals of the same race the hairs are highly variable not only i
thus
quite
tufts
the h
rudiments of the uniform hairy coat of the lower animals This view is rendered all the more probable as it is known that fine short, and pale coloured hairs on the limbs and other

I am informed by Sir James Paget that often several members of a family have a few hairs in their eyebrows much longer than the others so that even this slight peculiarity seems to be inherited These hairs too seem to have their representatives for in the chimpanzee and in certain species of Macacus, *there are scattered* hairs of considerable length rising from the naked skin above the eyes and correspondin to our eyebrows similar long hairs project from the hairy covering of the superciliary

month is thickly covered offers a more curious case It is first developed during the fifth month on the eyebrows and face and especially round the mouth where it is much longer than that on the head A moustache of this kind was observed by Eschricht[40] on a female fœtus but this is not so surprising a circumstance as it may at first appear for the two sexes generally

of the fœtal body are the same as in the adult, but are subject to much variability The whole surface including even the forehead and ears, is thus thickly clothed but it is a significant fact that the palms of the hands and the soles

coat of hair in those mammals which are born hairy Three or four cases have been recorded of persons born with their whole bodies and faces thickly covered with fine long hairs and this strange condition is strongly inherited,

the lanugo of a fœt

by a surgeon to a hospital for children have their backs covered by rather long silky hairs and such cases probably come under the same head

It appears as if the posterior molar or wisdom teeth were tending to become rudimen

[37] *The Physiology and Pathology of Mind* 2nd ed 1868 p 134

[38] Eschricht, Über die Richtung der Haare am menschlichen Körper *Muller's Archiv fur Anat und Phys* 1837 s 47 I shall often have to refer to this very curious paper

[39] Paget, *Lectures on Surgical Pathology* 1853 vol i p 71

[40] ... 40 47

recei ed dr gs f both fr m l rn

tary in th more ci ilised races of man. These teeth are rathe smalle than the ther m lars, as is likewise the case with th correspo di teeth in th chimpanzee and ang and th y have nly tw separate fang Th y d n t cut thro gh the gums till about th se enteenth year and I ha bee assured that th y are much m re liable t decay and are ari r lost than the th teeth b t this d nied by som mi t d nti ts. Th y are also much more l abl to ary both tru t re and

1

erally sound th y also diff from the th r molars in size, less than n th C casian races.[43] Prof Schaaffh usen accounts f thi d ff re ce bet ee th races by the post n d ntal porti of th j w be ng al sh rt ned in those th are ci lised [44] and this h rt ning may I presume, be ttributed t ci lised m n hab tually feeding on soft, cooked food and thus usin th j w l ss. I am nf rmed by M Brace that t is becoming quit common practice th United States to rem som of the m lar teeth f children, as the j w does t grow larg gh f th perfect d l p- m t f th rmal umber [45]

W th respect to th alun ntary canal, I ha e met with an account f nly si gl rud m nt,

rudim penda, small Can trin nas co man It is occas ally quite absent, or again i la g ly de l ped Th e passage is som tim s compl tely closed for half r two-th rds of its l gth with the terminal part consi ti g of a fl tt ned sol d expansio In the rang thi ap-

th ca se f d ath, f wh ch fact I h e lat ly heard tw instan thus a d e to small hard bod es, s ch as seeds, nt ring the passage,

hook lik process f bo compl ted b a band f ligam nt. Dr Struth rs,[48] wh l as losely tt ded to the ubject, has n w sh wn th t this pecul arity is som times nh rited, as t has occurred in a f the and in less than f ut f his se n children. Wh n present th gre t nerv in arı bly passes through t and thi cl arly indicate that t the h mo- l gu and rudim nt f the pra-cond l d f ram f th l w r animals. Prof Turn r tim tes, as he inf rms m th t occ rs in about pe cent f recent skelet ns. B t f th occasi nal d l pm nt f this tru t re in man s, as seems probabl d e to reversion, it is a ret rn t a ry anci nt f of thi gs, be cause in th high Q adruman t abse t.

actually m re than thrice as l g as the whol body [46] It som times p od ced to a l g grad ally taperi po t, d is sometim constr ted in parts. It ppears as if n conse- q ce f changed d t hab ts, th caecum had becom m h h rt ed ani ani mals, th rm f rm ppe dag being l ft as a

[43] Dr W bb, Teeth in M and the Anthropoid Apes, as q ted by D C Cart Blak in *Anthropological Review* July 1867 p. 299

[44] 'On n. *A atomy f V ertebrates* ol. iii., pp. 320 21 nd 325

[45] 'On th Prim ti F rm of the Skull,' Eng translat., in *Anthropological Review* Oct., 1868, p. 426

Prof M tegazza write t m from Fl rence, tha h has lately bee tudying th last m lar teeth in the diff re t races f man, d has com to th same conclusio as that gi in my t t, viz., that in th higher civilised races they ar the road to ards trophy liminat n.

[46] Owen, *Anatomy f V ertebrates*, ol. iii., pp 416 434, 441

tio t this peculiar tructure in man see his *Great Art sts nd Anatomists*, p. 63. See also importa t mem ir this process by D Grube in th *Bulle- t de l'Acad Imp de St. Péter bourg* tom xii., 1867 p. 448

There is another foramen or perforation in the humerus occasionally present in man which may be called the his ro- of ... an mals It is remarkable that this perforation seems to have been present in man much more frequently during ancient times than recently Mr Busk [51] has collected the following evidence on this head Prof Broca noticed the perforation in four and a half per cent of the arm bones collected in the Cimetiere du Sud at Paris and in the Grotto of Orrony the contents of which are referred to the Bronze period as many as eight humeri out of thirty two were perforated but this extraordinary proportion he thinks, might be due to the cavern having been a sort of family vault Again M Dupont found thirty per cent of perforated bones in the caves of the Valley of the Lesse belonging to the Reindeer period whilst M Leguay in a sort of *dolmen* at Argenteuil observed twenty five per cent to be perforated and M Pruner Bey found twenty six per cent in the same condition in bones from Vaureal Nor should it be left unnoticed that M Pruner Bey states that this condition is common in Guanche skeletons It is an interesting fact that ancient races in this and several other cases more frequently present structures which resemble those of the lower animals than do the modern One chief cause seems to be that the ancient races stand somewhat nearer in the long line of descent to their remote animal like progenitors

In man the os coccyx together with certain other vertebrae hereafter to be described though functionless as a tail plainly represent this part in other vertebrate animals At an early embryonic period it is free and projects beyond the lower extremities as may be seen in the drawing (fig 1) of a human embryo Even after birth it has been known in certain rare and anomalous cases [52] to form a small external rudiment of a tail The os coccyx is short, usually including only four vertebrae all anchylosed together and these are in a rudimentary condition for they consist with the exception of the basal one of the centrum alone [53] They are furnished with some small muscles one of which as I am informed by Prof Turner has been expressly described by Theile as a rudimentary repetition of the extensor of the tail a muscle which is so largely developed in many mammals.

The spinal cord in man extends only as far downwards as the last dorsal or first lumbar vertebra but a thread like structure (the *filum terminale*) runs down the axis of the sacral part of the spinal canal and even along the back of the coccygeal bone The upper part of this filament as Prof Turner informs me is undoubtedly homologous with the spinal cord but the lower part apparently consists merely of the *pia mater* or vascular investing membrane Even in this case the os coccyx may be said to possess a vestige of so important a structure as the spinal cord though no longer enclosed within a bony canal The following fact for which I am also indebted to Prof Turner shews how closely the os coccyx corresponds with the true tail in the lower animals Luschka has recently discovered at the extremity of the cocc ...

... Krause and Meyer to examine the tail of a monkey (Macacus) and of a cat in both of which they found a similarly convoluted body though not at the extremity

The reproductive system offers various rudimentary structures but these differ in one important respect fro ...

a ... t ... ex and represented in the other by a mere rudiment Nevertheless, the occurrence of such rudiments is as difficult to explain on the belief of the separate creation of each species, as in the foregoing cases. Hereafter I shall have to recur to these rudiments, and shall shew that their presence generally depends merely on inheritance that is, on parts acquired by one sex having been partially transmitted ... n fortu be ... fre ...

[50] Mr St Geo g Mi rt T act Phil Soc 186 p 310
[51] O th C e G b lt T n ct of the Int ... C ... J P h ... ol gy Th rd ... 1869 p 1 9 Pr f Wyman ... h ... (F th ... R port ... body M ... m 1871 p 20) th t this perforation prese t ... thi ty ... pe ce t ... ren ... fro ... c ... n th West ... ted St tes ... d n Fl rda It freq ... th ... se ... gro ...
[52] Q trefages has l t ly collected th ... e ... n th ... b t P e d C ... 186 1868 p 6 ... 1910 Fl ... l ... ted ...
... n er ... d Arch f Zoolog Dec lst 18 1)
[53] O th N t ... f Lmb 1849 p 114

t th th I ill in this place only gi some instance of such rudiments. It is w ll kn wn that n th males of all mammals, luding man, rudimentary mammae exist. These in se ral n tances ha e becom w ll d l ped and ha lded cop u pply of milk. Th ir esse tial id ntit in th t o se s lik wise shewn by their occasi nal mpath tic enlargement in both duri an ttack of th m asles. Th sicula pros at ca, wh h has been observed man mal mamm ls, n w uni ll acknowledged t be th h m lo u f th

f

l

uson. ......

those mammals wl ch th tru f mal ut rus bifurcates, f th males of these th sic la likewise bif rc tes.[34] Some oth rudim tary tructure belonging t th reprod t e s- l m m ht ha been h re add ced.[35]

Th bear f th three gre t classes of fact now given is unmistakabl B t t would be peril us full t recapitulate th lin of argum t gi n in d tail in m Origin f Species Th h m l gical con truct n of th wh le fram in th m mbers f th sam lass is n- t lligibl if w admit th descent from comm pro nit t geth w th th s bse- que t adapt ti t di ersified cond tions. On an th w th similarit of patt rn be- t een th hand of man m nk y th foot of h rse the fl ppe l seal, th wing d a bat, & tt l plicable [36] It sci n- tific planat on t assert that th ha e all bee f rmed th sam d al plan. W th respect t d l pm t, w can learly und tand th princip f an t perven- ing t rath lat mb period and be nh nted t correspondi g period h w it s th t th e mbryos of wonderfull d ff rent f rms sh uld till retain, m re r less perfectl th truct re of th r common pro nitor No the xplanat n has r been gi n f th marv llous fact that the mbryos of man, d g seal, bat, reptil &c., can t first hardl be disti gu shed from each the In ord r to und rstand the exi tence of rud m tary or gans, we ha onl to ppose that a f rm r progenit r possessed th parts i t on i a pe fect st t and that und hanged hab ts l bf they became gre tl reduced tl from simpl d suse or throu h the natural select n of those indi duals wh h w re l a t ncumbered w th a pe fl us part, aided by th the means pre usl ndicated

Th w an und rstand how t has come to pass that man and all oth rt brate animals ha been constru ted on the sam general mod l, wl th y pass through the sam arl st ges of d lopm nt, and wh tl retai certain rud m nts in comm n. Consequ tl w cht frankl to admit th r communit of descent to take any th r w is to admit

wh animal series, and consid r the d nce d ri ed from their affinity or classification, their geographical d tribution and geol gical s ccess n. It is nl our n tural pre dice

t tructure and d lopm t of man, and oth mammals, should h e bel ed that ach was th wo k f separat act of cre ti n.

[34] Leuckart in Todd *Cyclopæd of Anatomy* 1849– 2, d p. 1411 f ma this orga is ly from three t six li es le gth, b t lik so ma y other rudime tary part t is ariable d l p- me t as ll as in ther hara ters.

[35] see this bject, Owen, *Anatomy f Vertebrates* ol iii pp. 6 3, 6 6, 06.

[36] Prof Bianconi, in recently published work, illustrated b admirable engra ngs (*La Théorie Darwinienne et la création dite indépendante* 1 4) takes ours t show that homological structures, in the bove nd other cases, ca be fully xplained mechanical principles, accordance th their uses. No one has she so ll, h w admirabl, uch struc ures are adapted for their final purpose nd this adaptation can, as I l liev be plained through natural selection. I considering the wing of bat, he brings forward (p.) hat ppears t m (t use A gust Comte words) mere metaphysical principle namel, the preserv tion in ts integrit of the mammalian nature of the animal. I only f w cases does he iscuss rudim ts, nd then onl, those part hich are partiall, rudimentary uch as the little hoof of the pi nd ox, hich d not touch the ground these he ho clearly t be of service t the animal It is nfortunat that he did not conside uch cases as the min t teeth, which ne er cut through the jaw in the ox, or the mammae of male quadrupeds, or the wings of certain beetles, xisting und the soldered ing-covers, or the estiges of the pistil nd stamens in rious flow rs, nd man, the such cases. Although I gre tl admire Prof Bianconi work, yet the belief w held t, most naturalists ser is t m left nshaken, that homological tructures are inexplicable on the principle of mere adaptation.

There is another foramen or perforation in the humerus occasionally present in man which may be called the inter condyloid This occurs but not constantly in various anthropoid and other apes[50] and likewise in many of the lower animals It is remarkable that this perforation seems to have been present in man much more frequently during ancient times than recently Mr Busk[1] has collected the following evidence on this head Prof Broca noticed the perforation in four and a half per cent of the arm bones collected in the Cime tiere du Sud at Paris and in the Grotto of Orrony the contents of which are referred to the Bronze period as many as eight humeri out of thirty two were perforated but this extraordinary proportion he thinks might be due to the cavern having been a sort of family vault Again M Dupont found thirty per cent of perforated bones in the caves of the Valley of the Lesse belonging to the Reindeer period whilst M Leguay in a sort of *dolmen* at Argenteuil observed twenty five per cent to be perforated and M Pruner Bey found twenty six per cent in the same condition in bones from Vaureal Nor should it be left un noticed that M Pruner Bey states that this condition is common in Guanche skeletons It is an interesting fact that ancient races in this and several other cases more frequently present structures which resemble those of the lower animals than do the modern One chief

In man the os coccyx together with certain other vertebræ hereafter to be described though functionless as a tail plainly represent this part in other vertebrate animals At an early embryonic period it is free and projects beyond the lower extremities as may be seen in the drawing (fig 1) of a human embryo Even afte birth it has been known in certain rare and anomalous cases[52] to form a small external rudiment of a t il Th os coccyx is short usually including only four vertebræ all anchylosed together and these are in a rudimentary condition for they consist with the exception of the basal one of the centrum alone[53] They are furnished with some small muscles one of which as I am informed by Prof Turner has been expressly described by Theile as a rudimentary repetition of the ex tensor of the tail a muscle which is so largely developed in many mammals

The spinal cord in man extends only f

a o c sacral part of the spinal canal and even along the back of the coccygeal bones The upper part of this filament as Prof Turner informs me is un doubtedly homologous with the spinal cord but the lower part apparently consists merely of the *pia mater* or vascular investing mem brane Even in this case the os coccyx may be said to possess a vestige of so important a structure as the spinal cord though no longer enclosed within a bony canal The following fact for which I am also indebted to Prof Turner shews how closely the os coccyx corresponds with the true tail in the lower ani mals Luschka has recently discovered at the extremity of the coccygeal bones a very pe culiar convoluted body which is continuous with the middle sacral artery and this discov ery led Krause and Meyer to examine the tail of a monkey (Macacus) and of a c t and th of which they found a similarly convoluted body though not at the extremity

The reproductive system offers various rudi mentary structures but these differ in one important respect from the foregoing cases Here we are not concerned with the vestige of a part which does not belong to the species in an efficient state but with a part efficient in the one sex and represented in the other by a mere rudiment Nevertheless the occur ce of such rudiments is as difficult to explain on the belief of the separate creation of each spe cies, as in the foregoing cases Hereafter I shall have to recur to these rudiment and I shall shew that their presence generally depends merely on inheritance that is on parts acquired by one sex having been partially transmitted

[50] M St Geo g M rt *T ct ns I h I Soc* 186 p 310

[1] O i ll C v of G b lt *T ns ctio s f th Inte at o l C g f I h tori l h ol gy* Th rd n 1869 p 159 Prof Wym n h s l t ly h (*F rth An l Repo t I body M m* 1871 p 20) th t this perf rat n is p ese t

this ub ect. *R r d C* Sci *t f q* 186 1868 p 6 It 1840 Fl sch l l ted a l u

h ll *V ederl d t h f Zoolog* D cember 18 1) 90) *O U V t f I mb* 1849 p 114

of the lower animals th ugh th facts are copious no gh with respect to th latt r So regard to mental qualities, their transmissi n is manif st in our d gs, horses, and other domestic animals. Besides pecial tastes and habits, gen ral int lligence courage bad and good temper &c., are certainly transmitted. With man w see similar facts n almost e ry famil and w now know thro gh the d mirable labours f M Galton,[18] that g nius which implies a wond rfull compl combination of high faculties, t nds t be inh rited and, th th hand, t is too certain that insanit and d t riorated me tal powers likewise run families.

With respect to th causes of ariab lit w are al cases ery gnora t but w can see that in man as in th l animals, th y stand in som relation to th conditions to which each pecies has been e posed, during se ral generations. Domesticated animals ary more than those in stat of nature and this is pparentl d to th di rsified and changing nature of th co d ti ns t wh ch they h been subjected. In this respect th di re t races of man resembl d mesti ated animals, and so d th individuals f th same race wh inhab tin ry wid area, lik that of Am rica. W see th infl nce of di rsified conditi ns in th m re civilised nati ns for the m mbers belo ging t different grades of rank, and f llowing diff rent occupati ns, prese t greate rang of charact than do th m mbers of barbarous nati ns. B t th uniformit of sa age has oft n been exag g rated, and som cases can hardl be said to exist. It is, ne rtheless, an rror to speak of man, if w look on to th conditi ns to which h has been exposed, as far more d mesticated than an other animal. Som sa a races, such as th Au tralians, are not xposed to more di rsified cond t ons than are many pecies which ha wid range. In anoth and much more important re pect, man diff rs widel from an trictl domesticated animal for his breeding has long been co trolled, ther by m thodical o un conscious selecti n. No race or body of men has been so compl tely subj g ted by othe m n, as th t certai ndi duals sh uld be preserved and thus unconsci usly selected from som l w xcelling in utility to thei mast rs. N b certai mal and f male ind d als I t ll p cked out and m tched,

—

cal selecti n f t i asserted that many tall men were reared n th llages inhabited by th grenadiers and th r tall wi es. In Sparta, also, a form of select n was f llowed f it was acted that all children should be examined sh rtly aft birth the w ll formed and g rous being preser ed, the others left to perish.[19]

If w consid r all the aces of man as f rming a singl spec s, his ran e enorm us b t som separat races, as th Am ricans and Pol n sians, ha ry wid ranges. It a w ll-kn wn law that wid ly rang pecies are much more variable than species with re tricted ranges and th variabil ty of man may with m re truth be compared with that of wid l ranging pecies, than with that of d mesticated animals.

N t nl does ariab lit ppear to be in d ced in man and th low animals by the

pro ene t of mankind. H saw likewise that wealth ofte hecks the proper action of sexual selection. H thus writes

With kine nd horses, Kurnus, we proceed
By asonable rules, and hoose br ed
For profit and ncrease at y pric
Of sound stock without defect or vice
But, th daily matche that we make,
The price is everything for money sake,
Men marry women ar marriag gi en
The kurl or ruffian, that wealth has thriven,
M y match his f pri g with the proud st ones.
Thus everythi g is mix d, noble nd base!
If then ut rd manner form, and m nd,
Y find degraded, motley kind,
Wonder no mor my friend! the cause is plain,
And to lament the consequenc is vain.

(*The Works of J Hookham F ere*, vol. ii., 1872, p. 334.)

[18] *Hereditary Genius an I quiry nto its Law and Consequences*, 1869

M B tes remarks (*The Naturalist on the Amazons*, 1863, ol. ii., p. 159) with respect to the Indians of the same South American tribe no t of them were ll similar in the shape of the head one ma had an oval visage with fine features, and another was q te Mongolian in breadth and prominence of cheek, spread of nostrils, and obliquity of eyes.

Blumenbach, *Treatises on Anthropology* Eng. translat., 1865, p. 205.

CHAPTER II

ON THE MANNER OF DEVELOPMENT OF MAN FROM SOME LOWER FORM

It is manifest that man is now subject to much variability No two individuals of the same race are quite alike We may compare millions of faces and each will be distinct There is an equally great amount of diversity in the proportions and dimensions of the various parts of the body the length of the legs being one of the most variable points [1] Although in some quarters of the world an elongated skull and in other quarters a short skull prevails yet there is great diversity of shape even within the limits of the same race as with the aborigines of America and South Australia—the latter a race probably as pure and homogeneous in blood customs and language as any in existence —and even with the inhabitants of so confined an area as the Sandwich Islands [2] An eminent dentist assures me that there is nearly as much diversity in the teeth as in the features The chief arteries so frequently run in abnormal courses that is has been found useful for surgical purposes to calculate from 1040 corpses how often each course prevails [3] The muscles are eminently variable thus those of the foot were found by Prof Turner[4] not to be strictly alike in any two out of fifty bodies and in some the deviations were considerable He adds that the power of performing the appropriate movements must have been modified in accordance with the several deviations Mr J Wood has recorded[5] the occurrence of 295 muscular variations in thirty six subjects and in another set of the same number no less than 558 variations those occurring on both sides of the body being only reckoned as one In the last set, not one body out of the thirty six was found totally wanting in departures from the standard descriptions of the muscular system given in anatomical text books A single body presented the extraordinary number of twenty five distinct abnormalities The same muscle sometimes varies in many ways thus Prof Macalister describes[6] no less than twenty distinct variations in the *palmaris accessorius*

The famous old anatomist, Wolff[7] insists that the internal viscera are more variable than the external parts *Nulla particula est quæ non aliter et aliter in aliis se habeat hominibus* He has even written a treatise on the choice of typical examples of the viscera for representation A discussion on the *beau ideal* of the liver lungs kidneys &c. as of the human face divine sounds strange in our ears

The variability or diversity of the mental faculties in men of the same race not to mention the greater differences between the men of distinct races is so notorious that not a word need here be said So it is with the lower animals All who have had charge of menageries admit this fact and we see it plainly in our dogs and other domestic animals Brehm especially insists that each individual monkey of those which he kept tame in Africa had its own peculiar disposition and temper he mentions one baboon remarkable for its high intelligence and the keepers in the Zoological Gardens pointed out to me a monkey belonging to the New World division equally remarkable for intelligence Rengger also insists on the diversity in the various mental characters of the monkeys of the same species which he kept in Paraguay and this diversity as he adds is partly innate and partly the result of the manner in which they have been treated or educated [8]

I have elsewhere[9] so fully discussed the subject of inheritance, that I need here hardly add anything. A greater number of facts have been collected with respect to the transmission of the most trifling, as well as of the most important characters in man than in any

[1] *Investigations in the Military and Anthropological Statistics of American Soldiers* by B A Gould 1869 p 256

vol 1844

Transactions of the Royal Society of Edinburgh, vol xxiv pp 175 189

Proceedings Royal Society 1867 p 544 also 1868 pp 483 524 There is a previous paper 1866 p 229

Proc R Irish Academy vol x 1868 p. 141

1 78 rt u p 217

tion, vol ii chap xii.

of the l w r animal th ugh the facts are cop us gh with respect to th l tt r Som r ard to m tal qualities, their transmiss on h

W h m w see similar f ct i alm y l

With re pect to th se f ariab lity we ar all case ry gn t b t w an e that man as the l animals, th y tand in som rel tion to th co dit n to which ach peci has been posed d g se ral g ti s. H m t cated animal ary m re than those n tal I n tur and thus ppare tly d to th d fied and changi g t re f th co d t ns t wh ch th y h bee bjected In this pect th d ff re t ace f man resembl d m t ted animals, and so d th di d als f th sam race wh nhab ting ery w d ar a, l k that f Am rica. W e th infl nce f d sified condit tl m re ca al sed t f th m mb rs b l gi g t d ff rent grades of ank, and f ll g d ff rent occupat ns, prese t gre te ang f characte than d th m mb f barbarous ti ns. B t th unif rmity f sa ag has ft be n xag g ted and som case can hardly b said to xist It s, n rth l ss, an ro t speak of man, f look nly to tl cond ti ns to which h has bee exposed as far m re d mesticated th an th animal Some sa ag aces ch as tl A t alians, are n t exposed to m re d rs fied co d t ns than ar many peci whi h h w d ange. In an th nd m ch m mportant respect, man d ff rs w d ly from any tri tly d m ti cated animal f his breed g has n l g

Hereditary Genius I quiry *to its La nd Consequences* 1869

M H tes remarks (*The Nat alist on the Ama-*

zons.

Blume bach *T eat se Anthr pology* E g translat., 1865 p 205

served and th s unco sc usly selected from som l w ccll ng i tu ty to th i mast rs. N r h e ce t male and f m le nd v d ls f t i lly p ked t and m tched

th grenad rs and th tall w s. In Sparta, lso f m f select n was f ll ed f it was acted th t all children sl o ld b mi ed sh rtly aft r birth the well f rmed and vig rous being preser ed, the oth rs l ft to perish [1]

If we conside all the ace of man as f m g s gle pecr s, h an e e rm s b t some separ te ac s, as th Am ricans and P ly ans, h ry w de rang s. It w ll kn wn law that w d ly r ging spec s are m h m re ariabl th n speci with re tricted ange d the ariab l ty of man m y witl more t th be compared w th th t f w d ly ra g g pecu s, than w th th t f d m ticated animals.

Not nly does ri b l ty ppear to be n d ced in man and the l w animals by the

H thus writ

With l ne nd hor es A vous w proceed
By aso ble ules nd hoo b eed
For pr f t nd ncr ll y pri
Of so nd stock without defect or vice.

M y match hir lf pri g with the proudest nc
Thus everyth g is mix d, oble nd bas l
If then utw d m nner form, nd m nd,
I find us degraded, motley kind,
W nder no mor my friend! the us plo n.
And to lament the consequenc ra

(*The W rk of J Hookham F rr* ol. ii., 18 2, p 3..)

same general causes but in both the same parts of the body are effected in a closely analogous manner This has been proved in such full detail by Godron and Quatrefages that I need here only refer to their works [14] Monstrosities which graduate into slight variations are likewise so similar in man and the lower animals that the same classification and the same terms can be used for both as has been shewn by Isidore Geoffroy St Hilaire [15] In my work on the variation of domestic animals I have attempted to arrange in a rude fashion the laws of variation under the following heads — The direct and definite action of changed conditions as exhibited by all or nearly all the individuals of the same species varying in the same manner under the same circumstances The effects of the long continued use or disuse of parts The cohesion of homologous parts The variability of multiple parts Compensation of growth but of this law I have found no good instance in the case of man The effects of the mechanical pressure of one part on another as of the pelvis on the cranium of the infant in the womb Arrests of development, leading to the diminution or suppression of parts The reappearance of long lost characters through reversion And lastly correlated variation All these so called laws apply equally to man and the lower animals and most of them even to plants It would be superfluous here to discuss all of them [16] but several are so important that they must be treated at considerable length

The Direct and Definite Action of Changed Conditions —*This is a most perplexing subject* It cannot be denied that changed conditions produce some and occasionally a con

may be urged on the other side at least as far as the innumerable structures are concerned which are adapted for special ends There can however be no doubt that changed conditions induce an almost indefinite amount of fluctuating variability by which the whole organisation is rendered in some degree plastic.

In the United States above 1 000 000 soldiers who served in the late war were measured and the States in which they were born and reared were recorded [1] From this astonishing number of observations it is proved that local influences of some kind act directly on stature and we further learn that the State where the physical growth has in great measure taken place and the State of birth which indicates the ancestry seem to exert a marked influence on the stature For instance it is established that residence in the Western States during the years of growth tends to produce increase of stature On the other hand it is certain that with sailors their life delays growth as shewn by the great difference between the statures of soldiers and sailors at the ages of seventeen and eighteen

results namely that they did not relate to climate the elevation of the land soil nor even in any controlling degree to the abundance or the need of the comforts of life This latter conclusion is directly opposed to that arrived at by Villerme *from the statistics of*

lower orders within the same islands, or between the inhabitants of the fertile volcanic and low barren coral islands of the same ocean [18] or again between the Fuegians on the eastern and western shores of their country where the means of subsistence are very dif

precise result Dr Beddoe has lately proved that, with the inhabitants of Britain residence

Godron *De l'Espèce* 1859 tom ... Quatrefages *Unité de l'Espèce Humaine* 1861 Also

(1868) ...
Mr ... ... less, in the case of plants, on the nature of the soil.

... see Elphinstone's *History of India* vol. i p 324

in t wns and certain occ pat o s h de- t r ting nfl e ce on h ght and he infers certain t nt nh rited

m l co d t prou e

naxm hasth s gs

to activity und a l w t mpe ture and the h and kin d h gh n [20] It was fo m rl th ght th t th col r f th skin and th charact f th hair w re determined by light b t and lth gh t can hardly be d med th t som ffect is thu p od ced al most all bservers now agree that th ffect has bee ry mall en aft xpo ure dur ing many ges. But th ubject will be m re prope l discussed wh n w tre t f th dif f re t aces f mankind W th ur d m t animals th re are ground fo bel g th t cold and damp directl affect th growth f th hair b t I h t m t w th any d ce on this head in th case f man.

Effects f th ncr as d U d D sus of P rts.—It w ll kn wn th t use tre gth ns th m sel in th di d al, and compl te di se th d tru ti n f th prope rt weak ns th m Wh th y is d troyed th pti erv It becom trophied Wh n an art ry is tied th late al chann ls increase t nl in diam t but in th thickn ss and tre gth f th ir co ts. Wh n n kidn y ceases t act from disease, th th increase ize and doe d bl w k. B crease t f thi kness, but l gth from carry g gre t w ght [21] Diff re t occupa-

uiss

in th lat war w re l ng by 0 217 f an in h than those f th sold rs, th gh th

sail rs w re on an a rage horter men whilst th arms w re sh rt by 1 09 f an in h, and th ref re t f proporti n, short rel ti th less r h gl t. Th shortn ss f th arms i pparently d to th i great r use and i an un pected re lt b t sail rs chiefly use th i arms n pull ng and n supporting w ghts. W th sail rs, the g rth of d l l ptl f th n t p are

Pa guas Indians t s ccessi ha ing passed n arly th wh le li in anoes, with th r l w r trem t s m t l ss. Othe writ rs h come to a m lar co l si n in anal g us ases. Accordi g to Cranz [22] wi o l ed f a l g time w th th E quim ux, "Th n t s bel v th t nge- uit and d t rity n seal-c tchi g (th r high t art and rt e) i hereditary there s is reall som thi g in t, f th son of a cel b ted seal-catch will dist guis him self th gh h lo t hi f the in childhood B t th case t i m ntal ptitud quite as m h bod ly tructure wh ch ppears to

cause Th t th y are g rall mall r n re- fi ed and ci ilized m n than in hard w king m sa g s, ce tain. B t w th sa ag s, a M H rb rt Spencer [23] has remarked th

M mo Anthropological Society ol. iii.

Domestication, ol. ii. pp 97-300 U J ger Ube das La g sthum der Knoch n. Jen ische Zeitschrift, B. B ft. I vestigations, & by B A. G uld 1869 p. 288.

us geth er m P gu g 1860 s. 4 H story f G eenland, E g translat. 1 67 L

1833, p. 209

and it can hardly be doubted that this is due

and engravers are liable to be short sighted whilst men living much out of doors and especially savages are generally long sighted [29] Short sight and long sight certainly tend to be inherited [30] The inferiority of Europeans in comparison with savages in eyesight and in the other senses is no doubt the accumulated and transmitted effect of lessened use during many generations for Rengger[31] states that he has repeatedly observed Europeans who had been brought up and spent their whole lives with the wild Indians who nevertheless did not equal them in the sharpness of their senses The same naturalist observes that the cavities in the skull for the reception of the several sense organs are larger in the American aborigine than in Europeans and this probably indicates a corresponding difference in the dimensions of the organs themselves Blumenbach has also remarked on the large size of the nasal cavities in the skulls of the American aborigines and connects this fact with their remarkably acute power of smell The Mongolians of the plains of northern Asia according to Pallas have wonderfully perfect senses and Prichard believes that the great breadth of their skulls across the zygomas follows from their highly-developed sense

that from continually breathing a rarefied atmosphere they have acquired chests and lungs of extraordinary dimensions. The cells also of the lungs are larger and more numerous than in Europeans These observations have been doubted but Mr D Forbes carefully measured many Aymaras an allied race living at the height of between 10 000 and 15 000 feet and he informs me[34] that they differ conspicuously from the men of all other races seen by him in the circumference and length of their bodies In his table of measurements the stature of each man is taken at 1000 and the other measurements are reduced to this standard It is here seen that the extended arms of the Aymaras are shorter than those of Europeans, and much shorter than those of Negroes The legs are likewise shorter and they present this remarkable peculiarity that in every Aymara measured the femur is actually shorter than the tibia. On an average the length of the femur to that of the tibia is as 211 to 252 whilst in two Europeans measured at the same time the femora to the tibiæ were as 244 to 230 and in three Negroes as 258 to 241 The humerus is likewise shorter relatively to the forearm This shortening of that part of the limb which is nearest to the body appears to be as suggested to me by Mr Forbes a case of compensation in relation with the greatly increased length of the trunk The Aymaras present some other singular points of structure for instance the very small projection of the heel

These men are so thoroughly acclimatised to their cold lofty abode that when formerly carric eastern plai by high wag a frightful Forbes foun survived during served that they still inherited their characteristic peculiarities But it was manifest even without measurement that these peculiarities had all decreased and on measurement, their bodies were found not to be so much elongated as those of the men on the high plateau

seen by consulting Mr Forbes's mem From these observations, there can I think, be no doubt that residence during many gen

[29] It is a s re inf rior t distin t vision f the ll r f this to b th ord nary ange of is to the le gth f the v ss l and the h ight f the ma ts

[30] *The Variation of Animals and Plants under Domestication* ol i p 8

S geth ere to I g y 8 10 I ha had good oppo tun ties f r bse v g the e t rd y po rl t the I gia is See als Lawr nce (L sa lec nd v l iabl body l rg the cau of h rt ght, *C'est le t l as d de pre*

[31] Prichard *Phy al History f M nk nd* o ii utho ty f Bl m b h l 1841 p 311 f r the st tem nt by P ll s l 1844 p 407

[32] Quoted by Prichard *Researches into the Physical History of Mankind* l v., p 463

[34] Mr Forbe l ll p per is now publ hed in th *J al f the Ethnological Soc ty f London*, n w se es, ol ii 1870 p 193

erations t great l ts n t nds, both di rectl and indirectly to ind ce inh rited modificati ns in th proporti ns f th body [18]

Alth gh man may n t ha been much modified during the latt sta ges f his xist ence thro h th increased decreased use ▪ parts, th facts now ▪ en shew that his liability in this respect has n t been lost and w positi ly kn w that th sam law hold good with th l animals. Conse q tl w m inf r that wh n at rem te poch th prog nitors f man w re m transi tional stat and w re changing from quad ruped into b peds, n tural selecti n w ld probably h bee greatly aided by th in herited ffects of th increased d minished use of the diff re t parts of th body

Arrest of Dev lopment.—Th re is a dif f rence between arrested d l pm t and arrested gro th, f parts n th f rm tat contin to grow whilst till retaining thei early conditi n. Vari us m nstrosit es com und this head and som as l ft palate are known t be occasi nall inh rited. It will suffice f purpose to ref t th arrested brain-d lopm nt of m crocepl alo d ots, as described in V t m moir [19] Th kulls are small and th con l ti ns f th b ain are les complex than in rmal m n. Th fro tal sinus, th projecti th eye-brows, is larg ly d l ped and th j w are prognath to an *ff y t* d gree so th t these idiots som wh t resembl th l w t pes of manki d Th int llig ce and most of their m tal faculties, are xtrem ly feebl They cannot acquire th pow f peech, and are wh ll incapabl f prolonged attenti n, b t are m h gi to imitati n. Th y are food bef re ati g it. On dh t is described as oft n using his m th i aid of his hands, *whilst hunti g f l ce*. Th y are oft n filtl y in th hab ts, and ha e no sense of decency and se eral ases ha been publ shed of tl r bod es be ng remarkably hairy [20]

Reversio.—Man of tl cases to be h re gi n, m ght l e been trod ced und r th last h ading When truct re i arre ted in ts d l pm t, b t till continu s grow ▪ unt l t cl sel resembl s a correspo d g struct re in som l w r and adult m mber of th sam group, t m y in sense be con sid red as case f re rsi n. The l w m m bers in a group gi u som d a h w the comm n pro nit r was probably constructed and t s hardly cred ble that compl part, arre ted t an early phase f embry ni de- lopm nt, sh ld go growing so as ulti mat l to perf rm ts prope fun ti n, unl ss t had acq red ch power d ring som earl ▪ tat f exist nce, wh n the prese t e cep- ti al o arrested truct re was normal. The simple brai of a microcephal us id ot, in as far as t resembles th t f an pe may in this sense be said to ffer case of re ersion.[21]

[19] Prof Laycock ums p the character of brute-like id ts by calling th m *theroid Journal of Mental Science, July 1863* D Scott (*The D af nd D mb*, 2nd ed., 18 0 p 10) has ft bserved th imbeciles m lling their food See this sam bject, and the hairiness of idi ts, D Maudsley *Body and M nd*, 18 0 pp. 46-51 Pinel has also gi en triking case of hairiness in an idiot.

[21] I my *Variation f Animal nder Domestication* (ol. ii., p. 5) I ttrib ted th not ry are case of perrnum rary mammæ in wom to re rsi n. I was led to this as probable conclusion, by the additional mammæ being generally placed ym m trically th breast and more especiall from ne case in which singl ffici t mamma oc-

ture or trees. W are thus reminded f th d light sh wn by almost all bo n climbing trees and this again reminds h w lambs and kids, riginally alpin animals, del ght to frisk any hillock, h w small. Idi ts also resemble th low animals som th respects thus se ral case are recorded of their carefully sm lling ry m thful of

[18] D Wilck ns (*Landwirthschaft. Wochenblatt* No. 10, 1869 has lately p blished int re ting ssay she ing how domestic animals, which li in mountainous regions, ha their frames modified.

[19] *Mémoires sur les Microcéphales*, 1867 pp. 50, 125, 169 1 1 184-198.

p. 56, for case gi by D Hand ide, in hich tw brothers xhibited this peculiarity see also

There are other cases which come more strictly under our present head of reversion Certain structures regularly occurring in the lower members of the group to which man belongs occasionally make their appearance in him though not found in the normal human embryo or if normally present in the human embryo they become abnormally developed although in a manner which is normal in the lower members of the group These remarks will be rendered clearer by the following illustrations

In various mammals the uterus graduates from a double organ with t o [illegible] s i y

f o n having a slight internal fold as in the

pap r by D Bart l in *Reichert and du Bo s R ymond A h*

s e el l n f d

pa n f C ratod h h s p ovided w th a tt ul t d l y a s o b th s le of a ce tr l chain f bo t r m n great d fficulty in a im tt g that six r m r d gits n e side or o both sd m ght r p r through e- ver I m inf rm d by D out e n that the n as n eco d f a n n ha g tw nty fo r fin s d t ty f u t l w ch efly led t the co lu th t th y t I r

n e pl d the d ed t of n y I *rmat on der D m t l* why I n place l ttle rel ce th er nded l

higher apes and man The rodents exhibit a perfect series of gradations between these two extreme states In all mammals the uterus is developed from two simple primitive tubes, the inferior portions of which form the cornua and it is in the words of Dr Farre by the coalescence of the two cornua at their lower extremities that the body of the uterus is formed in man while in those animals in which no middle portion or body exists the cornua remain ununited As the development of the uterus proceeds the two cornua become gradually shorter until at length they are lost or as it were absorbed into the body of the uterus The angles of the uterus are still produced into cornua even in animals as high up in the scale as the lower apes and lemurs

Now in women anomalous cases are not very infrequent in which the mature uterus is furnished with cornua or is partially divided into two organs and such cases according to Owen repeat the grade of concentrative development attained by certain rodents Here perhaps we have an instance of a simple arrest of embryonic development with subsequent growth and perfect functional development for either side of the partially double uterus is capable of performing the proper office of gestation In other and rarer cases two distinct uterine cavities are formed each having its proper orifice and passage [39] No such stage is passed through during the ordinary development of the embryo and it is difficult to believe though perhaps not impossible that the two simple minute primitive tubes should know how (if such an expression may be used) to grow into two distinct uteri each with a well constructed orifice and passage and each furnished with numerous muscles nerves glands and vessels if they had not formerly passed through a similar course of development as in the case of existing marsupials No one will pretend that so perfect a structure as the abnormal double uterus in woman could be the result of mere chance But the principle of reversion by which a long lost structure is called back into existence might serve as the guide for its full development even after the lapse of an enormous interval of time

Pr fes or Canestrini after discussing the

by a I sore Geoff y St Hila B t t pre nt t is th saf t co rs t g p lt t th idea that th re is y r L t t t ll development f supernum ra y l t d r rs n to s me lo ly orga zed pr ge t f m n.

[39] Dr A F rr w ll k rt l the *Cycl p d f A tomy d Phy ology* l 1859 p 642 O *tomy f V tbr t* l 1868 p 68 Prof ss T rn *Ed b gh M d al J r l* F bru ry 1865

forming, and various analogous cases, ar r es t the same conclus n as that just g en. H adduces anoth nstance n th case of the malar bone [a] which, in some f the Q aurumana and oth r mammals, n rmall consists of tw parts ns. This is t cond ti n in the human fœtus wh n two m nths old and through arrested d lopm nt, t som times remains thus man wh n adult, m re pe call in th low progn th u races. H nce Canestrini cond des th t som ancu nt progenitor of man m t h had this bo n mall di ided int tw port ns, which aft wards becam f sed tog th I man th fro tal bon consists of single p ece b t in the mbryo, and in children, and in almost all the lowe mammals, t consists of two p eces separated b distinct suture This suture occasionall persists m re ess di ti tl in man aft maturit and m re freq tl in ancie t than in recent crania, especiall as Canestrini has observed, in those xhumed from the Drift, and belo gin t th bra h cephalic t pe Here agai h comes to th sam concl si as in th analogous case of the malar bones. In this, and th nstances presentl t be gi n, th cause of anc t races pproaching th low animals in ce tain charact rs m [illegible] freq ntl than d th mod rn races, ppears t be th t th latt tand t som hat gre t distance in th long lin of desce t from their arl semi human pro nit rs.

Various oth anomal es in man, more less analo ous t th f rego g, h been ad anced b diff re t thors, as cases of re so b t these seem not littl d btful, f w h to desce d extrem l low n th mammalian series, before we find such structures normally present.[a]

In man th cani teeth are perfectly f fici t nstrum nt fo mast t on. But th ir tru anin cl aract as O n[a] remarks, is ind ated b th conical f rm of the crown, which t rminates n an obtuse po t, is con ex o tward and fl t ub-co a e w thin, at the base f whi h urface th re is a feeble promi n nce Th coni al f rm is best pressed in th M lanian races, especiall th Australian. The canin is more deeply mplanted and b tro g fan than th incisors. N rth less, this tooth no lo ge serves man as a special w pon f t aring hi n m es r prey t m th ref re as far as ts proper function is concerned be consid red as rudim ntary In

ry larg collecti n of human skulls some ma be found as Haeck l[a] observes, w th tl cani teeth project con. d rabl be ond t th rs in th same mann as n th an thropom rphous pes, b t n a less degree In these cases, pen paces between th teeth n th o w are l ft f th reception of th c o n

f w are th anci t kulls which ha been examined compared t recent skulls, t is an int resti fact that in t least three case th canines project largel and n th N ul tt w th are pok n of as norm us.[a]

Of th anthropomorphous pes the m l s alo ha their canines full d loped but

[a] malar bones in se ral huma ul jects nd ce ta pes he cannot consider this dispos io of the parts as uppi accidental Anothe pape on this same point has bee p lis hed b D Sa otti he sutura dove (che Turin, 1 1 where he says tha traces of the division ma be d tected in t per ce t of adult skulls he also remarks ha more freque tl occurs in prognathous kull. of he Ar race ha in others See also G Delorenzi on he same bject Tre nuovi casi d malia dell osso malare Torino, 15 2 Also, E M Rosa Nuova ca rara anomalia dell' osso malare M dena, 1 2 nd more rec ll Gruber ha pamphlet the di ision of this bone I gi these ref rences because reviewer without an grounds or scruples, has thrown doubts on my statements.

[a] whole series of cases is gi by Isidore Geoffroy St Hilaire Hist. de Anomalies t m. iii, p. 437. A reviewer (Journal of Anatomy and Physiology, 1 p. 366) blames me much for ot ha g discussed the umerous cases, which have been recorded, of various parts rrested their development. H sa that, ccordi t my theory ery transie t condition of an organ, during its development, is not ly means t nd, b ll nce was nd tself This d es ot seem t m necessaril l hold good. Wh hould ot ariations occur durin earl period of d lopm t ha ing no relation

parts, hich ha no relation t forme tat of xi t nce occur t ear period, as w ll as during maturity

[a] Anatom f Vertebrates, ol iii, 1868, p. 323.

[a] Generelle Morphologie 1866, B . d

[a] C rl V t Lectures M Eng t nslat, 1864 p. 1 1

[a] C Carter Blake jaw from La N lett Anthropological Review 1867 p. 295. Schaaffhausen, ibid., 1868, p. 426.

...degree in the ... considerably ... fact of which I have been assured, that women sometimes have considerably projecting canines, is no serious objection to the belief that their occasional great development in man is a case of reversion to an ape-like progenitor. He who rejects with scorn the belief that the shape of his own canines, and their occasional great development in other men, are due to our early forefathers having been provided with these formidable weapons, will probably reveal by sneering the line of his descent. For though he no longer intends, nor has the power, to use these teeth as weapons, he will unconsciously retract his "snarling muscles" (thus named by Sir C. Bell),[6] so as to expose them ready for action, like a dog prepared to fight.

Many muscles are occasionally developed in man, which are proper to the Quadrumana or other mammals. Professor Vlacovich[7] examined forty male subjects, and found a muscle, called by him the ischio-pubic, in nineteen of them; in three others there was a ligament which represented this muscle; and in the remaining eighteen no trace of it. In only two out of thirty female subjects was this muscle developed on both sides, but in three others the rudimentary ligament was present. This muscle, therefore, appears to be much more common in the male than in the female sex; and on the belief in the descent of man from some lower form, the fact is intelligible; for it has been detected in several of the lower animals, and in all of these it serves exclusively to aid the male in the act of reproduction.

Mr. J. Wood, in his valuable series of papers,[8] has minutely described a vast number of muscular variations in man, which resemble normal structures in the lower animals. The muscles which closely resemble those regularly present in our nearest allies, the Quadrumana, are too numerous to be here even specified. In a single male subject, having a strong bodily frame, and well-formed skull, no less than seven muscular variations were observed, all of which plainly represented muscles proper to various kinds of apes. This man, for instance, had on both sides of his neck a true and powerful *levator claviculae*, such as is found in all kinds of apes, and which is said to occur in about one out of sixty human subjects.[9] Again, this man had a special abductor of the metatarsal bone of the fifth digit, such as Professor Huxley and Mr. Flower have shewn to exist uniformly in the higher and lower apes. I will give only two additional cases; the *acromio-basilar* muscle is found in all mammals below man, and seems to be correlated with a quadrupedal gait,[10] and it occurs in about one out of sixty human subjects. In the lower extremities Mr. Bradley[11] found an *abductor ossis metatarsi quinti* in both feet of man; this muscle had not up to that time been recorded in mankind, but is always present in the anthropomorphous apes. The muscles of the hands and arms—parts which are so eminently characteristic of man—are extremely liable to vary, so as to resemble the corresponding muscles in the lower animals.[12] Such resemblances are either perfect or imperfect; yet in the latter case they are manifestly of a transitional nature. Certain variations are more common in man, and others in woman, without our being able to assign any reason. Mr. Wood, after describing numerous variations, makes the following pregnant remark. "Notable departures from the ordinary type of the muscular structures run in grooves or directions, which must be taken to indicate some unknown factor, of much importance to a comprehensive knowledge of general and scientific anatomy."[13]

[6] *The Anatomy of Expression*, 1844, pp. 110, 131.

[9] See Prof. Macalister in *Proc. Royal Irish Academy*, vol. x. 1868, p. 124.

[10] Mr. Champneys in *Journal of Anat. and Phys.* Nov. 1871, p. 178.

[illegible] *Zoological Society* [illegible] the scale are numerous in the Lemuroidea.

[illegible] in the foot [illegible] [11] "The R[illegible] Dr. Haughton [illegible] (*Proc. R. Irish Academy*, June 27, 1864, p. 715) a remarkable case [illegible] *flexor pollicis longus* [illegible] This remarkable [illegible] many [illegible] possess the arrangement [illegible]

Th t th s unkn n facto s e r t n to a d sce t f man from som lo r f n in an f rm r t te f t ce m y be admitted as unmistak bl mann r n th h h t d g ee p b bl " It qu te n cre acc n less an bee o g et e co cect n b tw tl m Un th th hand if m n t d scended fr m some pe like re t re al d a on can be as s gned why c rt m scl sh ld n t s d d ly reappear fte n t rv l f m y th usand g t ons, n the sam man e as with h rse as a d m l d rk-col red stripe dd nly ppear n the l g a d h ld rs afte n te l f h ndreds, m p bably f th an l of g e at s. Th n s ca. f e c n a so

Correlated Va tion —In man, as n tle l we an n ls i any structures are so in t mat ly l ted tl t wh n o part nc so do s anotl e w tho t our l e g able in m st case to ass gn a y reason We n t s y wl th r tl e e part g rn tl e tl r or wh tl e b th ar gov rned by son e earl er de l ped pa t. Vari s m n tro iti s, as I Geoff y pe tedly n t are tl us int mately l H l g tru ture e p r

r mark u dep rt f m th i pr p r type tl ey al n t alw y m tate tl ose f th l g a d so co f h l r Tl

re l nished th corn m y b said t ep se t, rud m t y co d t tl am g ts n rm l tat n ta mammals. Some parts wh h rud me t ry man, as th coccy both se s, d tl m mm th mal sc re alw y p nt wh l t th rs a h as th p acondyl d f am n o ly oc as lly ppe d th f m ght h bec t od ced d tl h ad f n Th se se l re rs ry tru t as w ll as th tr tly d m tary es, al th

and u P fe so Schaaffl en fi t drew tt t n t th l t n ppare tly xi ti g between a m sc lar f ac e and th t gly p ed a-o b t l ridge wh h are so hara te ist f th l rac of na B d tl n t s wh cl c n be g o ped

o f r t ig ce th y appe to n tl t y ti g e se It can, howe b sh n that l a t ns wl tl on s t g f l gl t d d al d ff ces, o f t gly m ked d al rupt d ti n f t e d p d m ch more n th co t t t f tl g m than n th nat e f th nd t ns to l ch t l as b n b jected "

1864 p 138) iat th fl or pollicis to gu rem k bl from th ir rel t t th sam muscl

Rate f Inc ase —C l d p pul t h

o tw l e y ar At tl f m t tl

tly marked m er h t m y b co sidered as proof d mpl f th Dar p ncipl f re er n, law of he ta ce, thus departm t of nat m cal sci nce.

der Domest atio

Se th mem bl F y the P nciple f P p latio by th Re T Malthus, l. 1826 pp 6 517

present population of the United States (thirty millions) would in [illegible] years cover the whole terraqueous globe so thickly, that four men would have to stand on each square yard of surface. The primary or fundamental check to the continued increase of man is the difficulty of gaining subsistence, and of living in comfort. We may infer that this is the case from what we see, for instance, in the United States, where subsistence is easy, and there is plenty of room. If such means were suddenly doubled in Great Britain, our number would be quickly doubled. With civilised nations this primary check acts chiefly by restraining marriages. The greater death-rate of infants in the poorest classes is also very important; as well as the greater mortality, from various diseases, of the inhabitants of crowded and miserable houses, at all ages. The effects of severe epidemics and wars are soon counterbalanced, and more than counterbalanced, in nations placed under favourable conditions. Emigration also comes in aid as a temporary check, but, with the extremely poor classes, not to any great extent.

ha [illegible]

actu[illegible]y less in barbarous than in civilised races. We know nothing positively on this head, for with savages no census has been taken; but from the concurrent testimony of missionaries, and of others who have long resided with such people, it appears that their families are usually small, and large ones rare. This may be partly accounted for, as it is believed, by the women suckling their infants during a long time; but it is highly probable that savages, who often suffer much hardships, and who do not obtain so much nutritious food as civilised men, would be actually less prolific. I have shewn in a former work,[18] that all our domesticated quadrupeds and birds, and all our cultivated plants, are more fertile than the corresponding species in a state of nature. It is no valid objection to this conclusion that animals suddenly supplied with an excess of food, or when grown very fat; and that most plants on sudden removal from very poor to very rich soil, are rendered more or less sterile. We might, therefore, expect that civilised men, who in one sense are highly domesticated, would be more prolific than wild men. It is also probable that the increased fertility of civilised nations would become, as with our domestic animals, an inherited character: it is at least known that with mankind a tendency to produce twins runs in families.[59]

Notwithstanding that savages appear to be less prolific than civilised people, they would no doubt rapidly increase if their numbers were not by some means rigidly kept down. The Santali, or hill-tribes of India, have recently afforded a good illustration of this fact; for, as shewn by Mr. Hunter,[60] they have increased at an extraordinary rate since vaccination has been introduced, other pestilences mitigated, and war sternly repressed. This increase, however, would not have been possible had not these rude people spread into the adjoining districts, and worked for hire. Savages almost always marry; yet there is some prudential restraint, for they do not commonly marry at the earliest possible age. The young men are often r[illegible]

[illegible] r from her parents. With savages the difficulty of obtaining subsistence occasionally limits their number in a much more direct manner than with civilised people, for all tribes periodically suffer from severe famines. At such times savages are forced to devour much bad food, and their health can hardly fail to be injured. Many accounts have been published of their protruding stomachs and emaciated limbs after and during famines. They are then, also, compelled to wander much, and I was assured in Australia their infants perish in large numbers. As famines are periodical, depending chiefly on extreme seasons, all tribes must fluctuate in number. They cannot steadily and regularly increase, as there is no artificial increase in the supply of food. Savages, when hard pressed, encroach on each other's territories, and war is the result; but they are indeed almost always at war with their neighbours. They are liable to many accidents on land and water in their search for food; and in some countries they suffer much from the larger beasts of prey. Even in India, districts have been depopulated by the ravages of tigers.

Malthus has discussed these several checks, but he does not lay stress enough on what is probably the most important of all, namely

[18] '[illegible] of Animals and Plants under Domestication,' vol. ii. pp. 111-113, 163.

[59] Mr. Sedgwick, 'British and Foreign Medico-Chirurgical Review,' July, 1863, p. 1[illegible]0.

[60] 'The Annals of Rural Bengal,' by W. W. Hunter, 1868, p. 259.

nfanticid pecially f fem l nfant and th habt f procurn g b t n. Tl p ac tices w p l m y q art rs f th w ld and nf tic d seem f rme ly t l e p ailed as Mr M Lenn n[a] has h w n a till m tens seal Tl se p act ce ap peart h rigi ted n g recogn g the d ffi ulty r tl r th mposs b hty of pporting all th i fant th t b rn. L ce t ss m lso h added t th f re g ing checks but tl doe n t f ll from fail m ans f s b ist ce th gh th t reaso b h tl t som cas (as in J pan) t has been t t nally co r ged as m an f keeping d wn th p p lat n. If look back t an trem ly rem te epoch, b f m l ad rri ed t th d gnity f manhood h w ld h been gu ded m re by ist t and l ss by aso than are th l t sa ag t tl pre t t m Our arly m l m prog nit w ld t h p ac

Tl re uld ha bee n prud t l t t from m rri g and th sex w ld h f ly nited t an arly g H ce th p g nit rs f man w uld h t ded t m reas p dly b t hecks f som k d th pe od l co tant m t h k pt d wn th n mb s m re se rel than th xi t g sa ag s. Wl t th prec t re f tl se hecks w e an t sa any m re th n w th m t th anim l W kn w th t h and cattle, h l are n t tr m l p l fi an mals, wl first t rned loose So th Am a, ased t an n rr t Tl l phant th l est breed f ll kn rn nimals, w ld m f w tl sa d ar tock th h l w ld Th nse f ry pec f m nk y m t b

prod n the w ld h se and catt Am ca, w s t fir t m a y sens bl d gr e cre sed th t as cl d st ct becam fully tocked th sam power was diminished No d bt, m this se d m all th many checks co r d diff checks under dif f t m ta pe iodical d arth de-

N t l S le tio —W have now se th t man ar ble in body d mind and tl t th at s re and ced th dire tly indir ctly by the sam g n ral ca ses, a d bey th me g al l s, as w th th l um l Man ha p e d w d ly e th face f tl arth d m t h be n xp sed, d ing his incessa t m g t o " to the n o t d fied co d ti The inhab tant f T rr d l Fu g th C p f Good H p an l Tasmania th on h m sph re and f th t g o is th th r must have passed th gh many cl m t s, a d chan ed th r h b ts many time bef th y ca l ed th ir prese t h m " Th early p g t f m m t lso h t nded lik ll oth animals, t ha i sed bey d th m n f sub te ce th y m st, th f re oc as n lly h been p sed to struggle f x t ce d conseq ntly t th gid law f nat u l lect B efi l ari t ns of all k d will th th occa. lly h bit all l bee p se ed and inj es l mi ted I d t ref t st gly m ked d t ns f t t hi h occ nly t l te ls f t m b t t m re d d al d ffe W kn w f tance tl t th m scle f r h d d feet wl ch d t u po f m m t, are habl lik th se f th l w r an m l " *Io ce sant ar b lit H th n* the

self th ref comp lled t re t od ce — f rm of tl l ta tial thod y f hi h h ppe rs to be q t iconsc us,— nd t trod as se f

assert bey nd this

th ppos te d f th sam ind vidual.

present population of the United States (thirty millions) would in 657 years cover the whole terraqueous globe so thickly that four men would have to stand on each square yard of surface. The primary or fundamental check to the continued increase of man is the difficulty of gaining subsistence and of living in comfort. We may infer that this is the case from what we see, for instance, in the United States, where subsistence is easy, and there is plenty of room. If such means were suddenly doubled in Great Britain, our number would be quickly doubled. With civilised nations this primary check acts chiefly by restraining marriages. The greater death-rate of infants in the poorest classes is also very important; as well as the greater mortality, from various diseases, of the inhabitants of crowded and miserable houses, at all ages. The effects of severe epidemics and wars are soon counterbalanced, and more than counterbalanced, in nations placed under favourable conditions. Emigration also comes in aid as a temporary check, but, with the extremely poor classes, not to any great extent.

There is great reason to suspect, as Malthus has remarked, that the reproductive power is actually less in barbarous, than in civilised races. We know nothing positively on this head, for with savages no census has been taken; but from the concurre[illegible] f g

[illegible] may be partly accounted for, as it is believed, by the women suckling their infants during a long time; but it is highly probable that savages, who often suffer much hardship, and who do not obtain so much nutritious food as civilised men, would be actually less prolific. I have shewn in a former work,[59] that all our domesticated quadrupeds and birds, and all our cultivated plants, are more fertile than the corresponding species in a state of nature. It is no valid objection to this conclusion that animals suddenly supplied with an excess of food, or when grown very fat, and that most plants on sudden removal from very poor to very rich soil, are rendered more or less sterile. We might, therefore, expect that civilised men, who in one sense are highly domesticated, would be more prolific than wild men. It is also probable that the increased fertility of civilised nations would become, as with our domestic animals, an inherited character: it is at least known that with mankind a tendency to produce twins runs in families.[60]

Notwithstanding that savages appear to be less prolific than civilised people, they would no doubt rapidly increase if their numbers were not by some means rigidly kept down. The Santali, or hill-tribes of India, have recently afforded a good illustration of this fact; for, as shewn by Mr. Hunter,[61] they have increased at an extraordinary rate since vaccination has been introduced, other pestilences mitigated, and war sternly repressed. This increase, however, would not have been possible had not these rude people spread into the adjoining districts and worked for hire. Savages almost always marry; yet there is some prudential restraint, for they do not commonly marry at the earliest possible age. The young men are often required to shew that they can support a wife; and they generally have first to earn the price with which to purchase her from her parents. With savages the difficulty of obtaining subsistence occasionally limits their number in a much more direct manner than with civilised people, for all tribes periodically suffer from severe famines. At such times savages are forced to devour much bad food, and their health can hardly fail to be injured. Many accounts have been published of their protruding stomachs and emaciated limbs after and during famines. They are then, also, compelled to wander much, and, as I was assured in Australia, their infants perish in large numbers. As famines are periodical, depending chiefly on extreme seasons, all tribes must fluctuate in number. They cannot steadily and regularly increase, as there is no artificial increase in the supply of food. Savages, when hard pressed, encroach on each other's territories, and war is the result; but they are indeed almost always at war with their neighbours. They are liable to many accidents on land and water in their search for food; and in some countries they suffer much from the larger beasts of prey. Even in India, districts have been depopulated by the ravages of tigers.

Malthus has discussed these several checks, but he does not lay stress enough on what is probably the most important of all, namely

[59] 'Variation of Animals and Plants under Domestication,' vol. ii. pp. 111-113, 163.

[60] Mr. Sedgwick, 'British and Foreign Medico-Chirurg. Review,' July 1863, p. 170.

[61] 'The Annals of Rural Bengal,' by W. W. Hunter, 1868, p. 259.

ocal organs, which in th pes are used f r ttering anou signal-cries, or as in o e genus, musical cad nce B t in man the closel similar ocal rgans h become ad pted through the inherited ffects of use fo th tterance of rt culat langu

Turning n w to th n are t alh of m n, and th ref re t ll best represe tati es f ur arly pro nit rs, we find th t the hands of the Quadruman are con tructed n th sam general pattern as our wn, b t are far less perfectly ad pted f r d rsified uses. Their hand d not serv f locom ti n so w ll as th feet f d g as m y be seen in ch m nk ys as th himpanzee and orang, wl ch walk the t margins f the palms, n th knuckles.* Thei hands, h w are ad mirabl ad pted f r climbing trees. M nk s seiz thin branches ropes, with th thumb sid and th fingers and palm n th th in th sam mann as w do Th y can th also lift rath r larg objects, cl as the eck of bottle to th m ths. Baboons turn t es, and scratch p roots with their hands. Th seize n ts, sects, oth small objects with th th mb in ppo. t n t th fin rs, and n d bt th y thu tract ggs and u g from th n ts of b rds. Am ri can m nkey be t th wild ranges n th branches u til th rind cracked and th n tear t ff with th fingers f th two hands. In ld t t th break pe hard fru ts with

parasit s. Th roll d wn t s, o throw tl m t th mies rth l ss, th y are l m these arn u acti ns, and as I h m self see are q t unable t throw a t n th precisi

It seems t m far from tru that because object are grasped lumsily by m k s, m ch less pec alised rgan f preh nsi w ld ha served th m** eq all w ll w th their prese t hand On th co trary I see no reaso t d bt that m re perfectly co tructed hand would l bee an ad anta t th m pro ded th t tl w re t thus rend red less fitted f l mb g trees. It may suspect th t hand as perfect as tl t of man ould ha bee disad antageous f limbing f th most arboreal m nk n tl orld, nam l At les Am rica, Colobus in Africa, and Hylobate Asia, are th umbless, o their toes partially coh re so that th ir limbs are co verted i to mere gra p ing hooks.†

As soon as some ancient member n the gre t series of the primates came to be less arboreal wing to change n its mann f procuring ubsi t nce o to som cl ang th surround cond t o s, its hal t al man f progres n would ha e been mod fied and th t would h been rend red more tri tly quadrupedal or b pedal Baboons fre qu t hilly and rocky di tri ts, a d nly from necessity climb l gh trees ‡ and they h acquired almost th gait of d g Man alone has becom a b ped an I w can, I think, partl see h w h has com t assum hi erect at titud which f rms ne f his most con p us M n co ll t h ve ttained h

instrum ts, and b its correspondence w th th tellect gi es him uni rsal domini n. B t th hand nd arm could hardl h v be com perfect gh to h e manufactured w pons, o to ha e hurled tones and spears w th true aim, as l g as tl y were habit ally used f locomoti n and f supporti g th wh l weight of the bod as bef re re marked, so l g as th y w re specially fitted for limbing trees. S ch ro gh tre tm nt w uld also h e bl ted th sense f to ch, on whi h th ir d li t se larg l d pends. From th se causes alo t w ld h v been an ad antage t man to becom a b ped b t f r many ac ti ns it di pensable th t th arms and whol ppe part of th body h uld be free and h mu t f th nd tand firml n hi feet. To gain this gre t ad antag the feet h bee rend red flat and th gre t toe has been peculiarl modified th gh thi has n tailed th almost compl t loss f ts pow f preh nsi n. It accords with th principle f the divisi n of ph l gical labo pre ail g

* Ow n, *Anatomy of Vertebrates*, ol iii, p. 71

** *Quarterly Review* April, 1869 p. 39

† ... arboreal and traordi arily eti (Brehm, *Illustrierte Thierleben*, B i, s. 50), b t wh ther better climber tha the pecies of the lled ge era, I d t know It deserves tice that the *feet* of th sloths, th most arboreal nimals the world, are w derfull hooklik

‡ Brehm, *Illustrierte Thierleben*, B i, s. 80

The Hand, &c *Bridgewater Treatise* 1833, p. 38.

the one half which included all the individuals best adapted by their powers of movement for gaining subsistence or for defending them selves would on an average survive in greater numbers, and procreate more offspring than the other and less well endowed half

Man in the rudest state in which he now exists is the most dominant animal that has ever appeared on this earth He has spread more widely than any other highly organised form and all others have yielded before him He manifestly owes this immense superiority to his intellectual faculties to his social habits which lead him to aid and defend his fellows and to his corporeal structure The supreme importance of these characters has been proved by the final arbitrament of the battle for life Through his powers of intellect articulate language has been evolved and on this his wonderful advancement has mainly depended As Mr Chauncey Wright remarks A psychological analysis of the faculty of language shews that even the smallest proficiency in it might require more brain power than the greatest proficiency in any other direction [66] He has invented and is able to use various weapons tools traps &c with which he defends himself kills or catches prey and otherwise obtains food He has made rafts or canoes for fishing or crossing over to neighbouring fertile islands He has discovered the art of making fire by which hard and stringy roots can be rendered digestible and poisonous roots or herbs innocuous This discovery of fire probably the greatest ever made by man excepting language dates from before the dawn of history These several inventions, by which man in the rudest state has become so pre eminent are the direct results of the development of his powers of observation memory curiosity imagination and reason I cannot therefore understand how it is that Mr Wallace[67] maintains that natural selection could only have endowed the savage with a brain a little superior to that of an ape

Although the intellectual powers and social habits of man are of paramount importance to him we must not underrate the importance of his bodily structure to which subject the remainder of this chapter will be devoted the development of the intellectual and social or moral faculties being discussed in a later chapter

Even to hammer with precision is no easy matt[illegible] carp[illegible] as tr[illegible] self or in killing birds requires the most consummate perfection in the correlated action of the muscles of the hand arm and shoulder and further a fine sense of touch In throwing a stone or spear and in many other actions, a man must stand firmly on his feet and this again demands the perfect co-adaptation of numerous muscles To chip a flint into the rudest tool or to form a barbed spear or hook from a bone demands the use of a perfect hand for as a most capable judge Mr Schoolcraft [68] remarks the shaping fragments of stone into knives lances or arrow heads shews extraordinary ability and long practice This is to a great extent proved by the fact that primeval men practised a division of labour each man did not manufacture his own flint tools or rude pottery but certain individuals appear to have devoted themselves to such work no doubt receiving in exchange the produce of the chase Archæologists are convinced that an enormous interval of time elapsed before our ancestors thought of grinding chipped flints into smooth tools One can hardly doubt, that a man like animal who possessed a hand and arm sufficiently perfect to throw a stone with precision or to form a flint into a rude tool could with sufficient practice as far as mechanical skill alone is concerned make almost anything which a civilised man can make The structure of the hand in this respect may be compared with that of the

[66] Lim[illegible] of Natural Selection North American

publish d The Essay o M[illegible] has be n a[illegible]y crit cised by Prof Clap rède on of th most distinguished [illegible]ool gists in Eu ope [illegible] n art le p bl hed [illegible] the B bliothèq e U[illegible] er lle J[illegible] e 18[illegible]0 Th[illegible] r mark quoted in my te t w ll urpris[illegible] [illegible] ry o e wh has read M[illegible] Wallace s cel br ted pape[illegible] [illegible]n The Origin [illegible]f Hum n Race Deduced fro[illegible] th Theory of Natural Selectio[illegible] [illegible]ginally pul lish ed in the [illegible] thr pological Rev w M[illegible] y 1864 p. cl[illegible] m.

In th adult m le antl ropom rph pes, as Rutim y [n] and th h i ted it i th ff t th kull f the gre t d el p- me t f th j w m scl s th t c s t t d ff so gr tly many re pects f m th t f man, d has g n to th m l a truly right f l physi gn my Th f as th j w and teeth in man p g nito g ad ally b com r d d n th dult k ll ld l com to resembl m and m e tl t f xist g m A we h ll b e fte e a gr t ed tio of th canin teeth n the mal s w ld alm t ce ta nly ffect the t eth of the f m l th gl nh tan

A th ari s me t l facult s g ad ally d l ped th m l the b a w ld almo t rta ly becom l ge No e, I p um d bts th t th larg p po t wh h th s f m b ai be to his body m pared t th sam p po t i th g ll g l ly nn ted w th hi high m t l po W m t w th l ly anal fact th sect f n ants th

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rd s, l as beetl O th tl h nd no ppose tl t th t llect f any tw am

sol t mass f m tt tl th w n d f lly d fied ti cts, m tal p s, d affect f ts t y t th e b al gangl t sol g as th q rt f m ll p b ad U d this po t f ew th b ai f an ant f th m t m rv l f tom f m tt th w ld pe h p m so th th b f man.

Th b l f th t th t man m l se l t bet tl f th b ain and th d l pm t f th t llect al fac lt ppo ted by th compariso f tl kulls f sa ag d ci l sed aces, f anci t and

th m et th entury kulls from g a s in P ris we e larg r th i th se f om v lts of tl tu lftl ntury in th p p rti n of 1484 to 1426 and that th in ased as a e ta ed by m as em nts, was xclusi ly n th f t l part f tl skull—th seat f tl i t llect al faculties Pr cha d i persuaded th t the p esent inhab ta ts f Britain ha much m e capaci brai cases than the

re pect t the l we anim ls M E Lart t [n] by comp ri g tl ran f t tiary and r cent mammals bel g g t th sam group l as come to the r mark ble co clus th t the b m gen ally larg nd the convolut ns are m compl in the m r nt f rms On tl tl r l and I h shewn[n] th t tl e brains f d m ti abb t e consid bly red ed b lk n compar on w th those f th wild bb t r har and this m y b ttrib ted to th ha g been closely co fined duri g many g n ti ns, s th t tl y have rted the r i t llect, ti cts, sens and l t ty m m ts b t littl

Th g ad lly i as g w ght f the b ai and sk ll n m n m t h v nfluenced th d l pm nt f tl s pporti g sp al col m e e pecially wl il t he was b com ing rect A tl ch ge f po t on was be g b ght b t, th t l p ssur f tl e b ai will lso h e t fl ed th f rm f tl k ll f many facts h w h w asily th kull

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Ph losoph al T ctions 1869 p. 513

throughout the animal kingdom that as the hands became perfected for prehension the feet should have become perfected for support and locomotion With some savages however the foot has not altogether lost its prehensile power as shewn by their manner of climbing trees and of using them in other ways [24]

If it be an advantage to man to stand firmly on his feet and to have his hands and arms free of which from his pre eminent success in the battle of life there can be no doubt then I can see no reason why it should not have been advantageous to the progenitors of man to have become more and more erect or bipedal They would thus have been better *able to defend themselves with stones or clubs* to attack their prey or otherwise to obtain food The best built individuals would in the long run have succeeded best and have survived in larger numbers If the gorilla and a few allied forms had become extinct it might have been argued with great force and apparent truth that an animal could not have been gradually converted *from a quadruped into a biped as all the individuals in an intermediate condition would have been miserably ill fitted for progression But we know (and this is well worthy of reflection) that the anthropomorphous apes are now actually in an intermediate condition* and no one doubts that they are on the whole well adapted for their conditions of life Thus the gorilla runs with a sidelong shambling gait but more commonly progresses by resting on its bent hands The long armed apes occasionally use their arms like crutches swinging their bodies forward between them and some kinds of Hylobates, without having been taught can walk or run upright with tolerable quickness yet they move awkwardly and much less securely than man We see in short in existing monkeys a manner of progression intermediate between that of a quadruped and a biped but, as an unprejudiced judge [a] insists the anthropomorphous apes approach in structure more nearly *to the bipedal than to the* quadrupedal type

As the progenitors of man became more and more erect with their hands and arms more and more modified for prehension and other purposes with their feet and legs at the same time transformed for firm support and progression endless other changes of structure would have become necessary The pelvis would have to be broadened the spine pecu

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in man Various other structures which appear connected with man s erect position might here have been added It is very difficult to decide how far these correlated modifications are the result of natural selection and how far of the inherited effects of the increased use of certain parts or of the action of one part on another No doubt these means *of change often co operate thus when certain muscles and the crests of bone to which they are attached become enlarged by habitual use this shews that certain actions are habitually performed and must be serviceable* Hence the individuals which performed them best would tend to survive in greater numbers

The free use of the arms and hands partly the cause and partly the result of man s erect position appears to have led in an indirect manner to other modifications of structure The early male forefathers of man were as previously stated probably furnished with great canine teeth but as they gradually acquired the habit of using stones clubs or other weapons for fighting with their enemies or rivals they would use their jaws and teeth less and less In this case the jaws together with the teeth would become reduced in size as t t *from innumerable* ana me tion of o

teeth in male ruminants apparently in relation with the development of their horns and in horses in relation to their habit of fighting with their incisor teeth and hoofs

[24] H kel has an xcell t d us o n tl t ps by which m m bec me b ped N t l h S ho- 1868 07 D Bil l (C ft

O tl In ti F n fil Sk ll t n l t d 178 Ow

c u l les *La Terre* u (parate copy)

In the ad lt mal antl pomorphous pes, as Rütim y [17] and th s, ha n nsisted it is the ffect th sk ll f tl gre t d elop- m t f th j w muscle that ca se it to d ffe so gre tly in m y espects f m that of man, and has gi en to th se animals truly right ful physi gnomy Th f as th j s and teeth n man prog nitors gradually becom reduced i size th ad lt k ll w ld h come to resem l m and m re that f exist- m As w shall h afte see a great

As th ari us m tal facult g adually d loped tl msel th b ain ld alm t rtainly becom l g r N e l p ume d bts that tl la g p port wlu h the ze f man b ai be r to his body com pared to the sam p port th g rilla ang, l sely o cted ith his high r m tal po W mect th losely anal facts tl sects f i ant th ce e-

d rs, ch as beetles [7] O tl tl e hand, n pposes that th intellect f y t ant

w l te mas f us matte thus tl w n d rfully di rsified nstincts, m tal po rs, and affects us f ants are notr n us, y t th ir ce b al ganglia ar not so la g as th quarte of mall p n head Und thus po t f i w th brain f an ant is f th m t marv l lous toms f matte th ld pe hap m so than tl b ai f man.

Th bel f that th re xi ts n man som lose relat betwee th ize f th b ain and th d lopm t f th intellect al facult is pported by th c mpariso f th k lls f sa g and ci lised races f anc t and

Eur peans is 92.3 cul ic inches in Americans 87.5 in A at cs 87 1 and in Aust al ans ly 81 9 cul c in hes Professo B oca [10] *fo d th E* the m teenth century k ll fr m gra s in Pari w e large than tl se f om ults f tl e t elftl ce t ry m tl pr port on f 1484 to 1426 and that the n ased size, as ascer tained by measu m nts was exclus ly n tl f tal part f the kull—the seat of tl *i tellectual facult es Prichard is persuaded* th t th p ese t inhal ta ts f Britain h m ch mo capaci us b ai case than the anci t nhal tants. N v rtl eless, it m t be adm tted that som k ll of ery higl an t q ty h as tl fam us ne of Neande th l, a w ll d l ped an l capacious [11] W th r pect to the l e an mals, M. E Lartet [12] by compari g th crania f tert ary nd cent

ar m compl n tl m n ecent f rms. On tl otl l and I l e h wn [13] th t the b ains f d m t ral l t ar consid rably ed ced b lk, n comparisc w th th se f the w ld ral b t har and th may b ttrib- *uted to th ha i g been closely conf ed*

Th gradually c eas g w ght f the b ain and kull in man must h e infl ced th d l pm t f tl s pport g p nal *column, m pecially wh lst he was b om* ing ect As tl s cha ge of po ti n was be g *bro ght* abo t, th internal p ss f th b ain w ll lso ha nfl ed th f rm f th skull f ma y facts h w l w asily th kull

Die G enzen der Thierwelt, eine Bet acht g zu D rw Leh 1868 I

D ardin, *A nale de Scienc Nat* 3rd series, *Zoolog* t. m. 1850 p 203 See lso M Lowne *Anatomy nd Phy f the Musca* m t a, 18 0 p 14 My son, M F D rw n, dissected f me the cerebral g lia of the *Formic rufa*.

Philosophical T nsactions 1869 p. 513

[11] B oca thus plains th therwise inexplical le fact, that the mea capac ty of the kull f the *se t troglodytes of Lozère* is greater than that of *modern F nchmen.*

[12] *C mptes-rendus d Scienc &* June 1 1868

[13] *The V riation f A mals d Plants nder Domestication* I. i., pp 124-129

throughout the animal kingdom that as the hands became perfected for prehension the feet should have become perfected for support and locomotion With some savages however the foot has not altogether lost its prehensile power as shewn by their manner of climbing trees and of using them in other ways [6]

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As the progenitors of man became more and more erect, with their hands and arms more and more modified for prehension and other purposes with their feet and legs at the same time transformed for firm support and progression endless other changes of structure would have become necessary The pelvis would have to be broadened the spine peculiarly curved and the head fixed in an altered position all which changes have been attained by man Prof Schaaffhausen [8] maintains that the powerful mastoid processes of the human skull are the result of his erect position and these processes are absent in the orang chimpanzee &c and are smaller in the gorilla than in man Various other structures which appear connected with man's erect position might here have been added It is very difficult to decide how far these correlated modifications are the result of natural selection and how far of the inherited effects of the increased use of certain parts or of the action of one part on another No doubt these means of change often co operate thus when certain muscles and the crests of bone to which they are attached become enlarged by habitual use this shews that certain actions are habitually performed and must be serviceable Hence the individuals which performed them best would tend to survive in greater numbers

The free use of the arms and hands, partly the cause and partly the result of man's erect position appears to have led in an indirect manner to other modifications of structure The early male forefathers of man were as previously stated probably furnished with great canine teeth but as they gradually acquired the habit of using stones clubs or other weapons for fighting with their enemies or rivals they would use their jaws and teeth less and less In this case the jaws together with the teeth would become reduced in size as we may feel almost sure from innumerable analogous cases In a future chapter we shall meet with a closely parallel case in the reduction or complete disappearance of the canine teeth in male ruminants apparently in relation with the development of their horns and in horses in relation to their habit of fighting with their incisor teeth and hoofs

gi i good case of the us f th foot as preh l g n by man and has bo w tt n tl m of p ogress n of th h gh r pe t hs h I ll de n th f llowing paragr ph also O (f *atomy f V ert brat* l p 71) this l tt ubject

[7] l of Broca, La Con titut d v t bres cau lales *La Revue d' A thropolog* 1b p 6 (sepa ate copy)

[8] O tl Pri t F rm f tl Sk ll tran l ted in *A thropolog l Review* Oct 1868 p 428 O n (*A at my f V t b te* l 1866 p 51) n th mast d processe i th highe pes

became naked through the action of the sun. Mr. Belt believes[64] that within the tropics it is an advantage to man to be destitute of hair, as he is thus enabled to free himself of the multitude of ticks (acari) and other parasites, with which he is often infested, and which sometimes cause ulceration. But whether this evil is of sufficient magnitude to have led to the denudation of his body through natural selection, may be doubted, since none of the many quadrupeds inhabiting the tropics have, as far as I know, acquired any specialised means of relief. The view which seems to me the most probable is that man, or rather primarily woman, became divested of hair for ornamental purposes, as we shall see under Sexual Selection; and, according to this belief, it is not surprising that man should differ so greatly in hairiness from all other primates, for characters, gained through sexual selection, often differ to an extraordinary degree in closely related forms.

According to a popular impression, the absence of a tail is eminently distinctive of man; but as those apes which come nearest to him are destitute of this organ, its disappearance does not relate exclusively to man. The tail often differs remarkably in length within the same genus: thus in some species of Macacus the tail is longer than the whole body, and is formed of twenty-four vertebræ; in others it consists of a scarcely visible stump, containing only three or four vertebræ. In some kinds of baboons there are twenty-five, whilst in the mandrill there are ten very small stunted caudal vertebræ, or, according to Cuvier,[65] sometimes only five. The tail, whether it be long or short, almost always tapers towards the end; and this, I presume, results from the atrophy of the terminal muscles, together with their arteries and nerves, through disuse, leading to the atrophy of the terminal bones. But no explanation can at present be given of the great diversity which often occurs in its length. Here, however, we are more specially concerned with the complete external disappearance of the tail. Professor Broca has recently shewn[66] that the tail in all quadrupeds consists of two portions, generally separated abruptly from each other; the basal portion consists of vertebræ, more or less perfectly channelled and furnished with apophyses like ordinary vertebræ; whereas those of the terminal portion are not channelled, are almost smooth, and scarcely resemble true vertebræ. A tail, though not externally visible, is really present in man and the anthropomorphous apes, and is constructed on exactly the same pattern in both. In the terminal portion the vertebræ, constituting the os coccyx, are quite rudimentary, being much reduced in size and number. In the basal portion, the vertebræ are likewise few, are united firmly together, and are arrested in development; but they have been rendered much broader and flatter than the corresponding vertebræ in the tails of other animals: they constitute what Broca calls the accessory sacral vertebræ. These are of functional importance by supporting certain internal parts and in other ways; and their modification is directly connected with the erect or semi-erect attitude of man and the anthropomorphous apes. This conclusion is the more trustworthy, as Broca formerly held a different view, which he has now abandoned. The modification, therefore, of the basal caudal vertebræ in man and the higher apes may have been effected, directly or indirectly, through natural selection.

But what are we to say about the rudimentary and variable vertebræ of the terminal portion of the tail, forming the os coccyx? A notion which has often been, and will no doubt again be ridiculed, namely, that friction has had something to do with the disappearance of the external portion of the tail, is not so ridiculous as it at first appears. Dr. Anderson[67] states that the extremely short tail of *Macacus brunneus* is formed of eleven vertebræ, including the imbedded basal ones. The extremity is tendinous and contains no vertebræ; this is succeeded by five rudimentary ones, so minute that together they are only one line and a half in length, and these are permanently bent to one side in the shape of a hook. The free part of the tail, only a little above an inch in length, includes only four more small vertebræ. This short tail is carried erect; but about a quarter of its total length is doubled on to itself to the left; and this terminal part, which includes the

[64] 'The Naturalist in Nicaragua,' 1874, p. 209. As some confirmation of Mr. Belt's view, I may quote the following passage from Sir W. Denison ('Varieties of Vice-Regal Life,' vol. i. 1870, p. 440): "It is said to be a practice with the Australians, when the vermin get troublesome, to singe themselves."

[65] Mr. St. George Mivart, 'Proc. Zoolog. Soc.' 1865, pp. 562, 583. Dr. J. E. Gray, 'Cat. Brit. Mus.: Skeletons.' Owen, 'Anatomy of Vertebrates,' vol. ii. p. 517. Isidore Geoffroy, 'Hist. Nat. Gén.,' tom. ii. p. 244.

[66] 'Revue d'Anthropologie,' 1872; 'La Constitution des Vertèbres caudales.'

[67] 'Proceedings Zoological Society,' 1872, p. 210.

is thus effected. Ethnologists believe that it is modified by the kind of cradle in which infants sleep. Habitual spasms of the muscles, and a cicatrix from a severe burn, have permanently modified the facial bones. In young persons whose heads have become fixed either sideways or backwards, owing to disease, one of the two eyes has changed its position, and the shape of the skull has been altered apparently by the pressure of the brain in a new direction.[84] I have shewn that with long-eared rabbits even so trifling a cause as the lopping forward of one ear drags forward almost every bone of the skull on that side; so that the bones on the opposite side no longer strictly correspond. Lastly, if any animal were to increase or diminish much in general size, without any change in its mental powers, or if the mental powers were to be much increased or diminished, without any great change in the size of the body, the shape of the skull would almost certainly be altered. I infer this from my observations on domestic rabbits, some kinds of which have become very much larger than the wild animal, whilst others have retained nearly the same size, but in both cases the brain has been much reduced relatively to the size of the body. Now I was at first much surprised on finding that in all these rabbits the skull had become elongated or dolichocephalic; for instance, of two skulls of nearly equal breadth, the one from a wild rabbit and the other from a large domestic kind, the former was 3.15 and the latter 4.3 inches in length.[85] One of the most marked distinctions in different races of men is that the skull in some is elongated, and in others rounded; and here the explanation suggested by the case of the rabbits may hold good; for Welcker finds that short "men incline more to brachycephaly, and tall men to dolichocephaly;"[86] and tall men may be compared with the larger and longer-bodied rabbits, all of which have elongated skulls, or are dolichocephalic.

From these several facts we can understand to a certain extent, the means by which the great size and more or less rounded form of the skull have been acquired by man; and these are characters eminently distinctive of him in comparison with the lower animals.

Another most conspicuous difference between man and the lower animals is the nakedness of his skin. Whales and porpoises (Cetacea), dugongs (Sirenia) and the hippopotamus are naked; and this may be advantageous to them for gliding through the water; nor would it be injurious to them from the loss of warmth, as the species, which inhabit the colder regions, are protected by a thick layer of blubber, serving the same purpose as the fur of seals and otters. Elephants and rhinoceroses are almost hairless; and as certain extinct species, which formerly lived under an arctic climate, were covered with long wool or hair, it would almost appear as if the existing species of both genera had lost their hairy covering from exposure to heat. This appears the more probable, as the elephants in India which live on elevated and cool districts are more hairy[87] than those on the lowlands. May we then infer that man became divested of hair from having aboriginally inhabited some tropical land? That the hair is chiefly retained in the male sex on the chest and face, and in both sexes at the junction of all four limbs with the trunk, favours this inference—on the assumption that the hair was lost before man became erect; for the parts which now retain most hair would then have been most protected from the heat of the sun. The crown of the head, however, offers a curious exception, for at all times it must have been one of the most exposed parts, yet it is thickly clothed with hair. The fact, however, that the other members of the order of primates, to which man belongs, although inhabiting various hot regions, are well clothed with hair, generally thickest on the upper surface,[88] is opposed to the supposition that man

Review Oct. 1868, p. 419

[87] O en, Anatomy f V t b ate vol iii p 619

[88] Is d re Geoffroy St H la re remarks (Histoire N t Ch f l t m 18 9 215-217) the m f t m 1854 p 23) h er st tes th t th g rilla th hair is th er th b ck, wh re t is partly rubbed off th n th l er urface.

merly considered sufficiently the existence of structures, which, as far as we can at present judge, are neither beneficial nor injurious; and this I believe to be one of the greatest oversights as yet detected in my work. I may be permitted to say, as some excuse, that I had two distinct objects in view; firstly, to shew that species had not been separately created, and secondly, that natural selection had been the chief agent of change, though largely aided by the inherited effects of habit, and slightly by the direct action of the surrounding conditions. I was not, however, able to annul the influence of my former belief, then almost universal, that each species had been purposely created; and this led to my tacit assumption that every detail of structure, excepting rudiments, was of some special, though unrecognised, service. Any one with this assumption in his mind would naturally extend too far the action of natural selection, either during past or present times. Some of those who admit the principle of evolution, but reject natural selection, seem to forget, when criticising my book, that I had the above two objects in view; hence if I have erred in giving to natural selection great power, which I am very far from admitting, or in having exaggerated its power, which is in itself probable, I have at least, as I hope, done good service in aiding to overthrow the dogma of separate creations.

It is, as I can now see, probable that all organic beings, including man, possess peculiarities of structure, which neither are now, nor were formerly of any service to them, and which, therefore, are of no physiological importance. We know not what produces the numberless slight differences between the individuals of each species, for reversion only carries the problem a few steps backwards, but each peculiarity must have had its efficient cause. If these causes, whatever they may be, were to act more uniformly and energetically during a lengthened period (and against this no reason can be assigned), the result would probably be not a mere slight individual difference, but a well-marked and constant modification, though one of no physiological importance. Changed structures, which are in no way beneficial, cannot be kept uniform through natural selection, though the injurious will be thus eliminated. Uniformity of character would, however, naturally follow from the assumed uniformity of the exciting causes, and likewise from the free intercrossing of many individuals. During successive periods, the same organism might in this manner acquire successive modifications, which would be transmitted in a nearly uniform state as long as the exciting causes remained the same and there was free intercrossing. With respect to the exciting causes we can only say, as when speaking of so-called spontaneous variations, that they relate much more closely to the constitution of the varying organism, than to the nature of the conditions to which it has been subjected.

Conclusion.—In this chapter we have seen that as man at the present day is liable, like every other animal, to multiform individual differences or slight variations, so no doubt were the early progenitors of man; the variations being formerly induced by the same general causes, and governed by the same general and complex laws as at present. As all animals tend to multiply beyond their means of subsistence, so it must have been with the progenitors of man; and this would inevitably lead to a struggle for existence and to natural selection. The latter process would be greatly aided by the inherited effects of the increased use of parts, and these two processes would incessantly react on each other. It appears, also, as we shall hereafter see, that various unimportant characters have been acquired by man through sexual selection. An unexplained residuum of change must be left to the assumed uniform action of those unknown agencies, which occasionally induce strongly marked and abrupt deviations of structure in our domestic productions.

Judging from the habits of savages and of the greater number of the Quadrumana, primeval men, and even their ape-like progenitors, probably lived in society. With strictly social animals, natural selection sometimes acts on the individual, through the preservation of variations which are beneficial to the community. A community which includes a large number of well-endowed individuals increases in number, and is victorious over other less favoured ones; even although each separate member gains no advantage over the others of the same community. Associated insects have thus acquired many remarkable structures, which are of little or no service to the individual, such as the pollen-collecting apparatus, or the sting of the worker-bee, or the great jaws of soldier-ants. With the higher social animals, I am not aware that any structure has been modified solely for the good of

hook like portion serves to fill up the inter space between the upper divergent portion of the callosities so that the animal sits on it and thus renders it rough and callous Dr Anderson thus sums up his observations These facts seem to me to have only one ex planation this tail from its short size is in the monkey s way when it sits down and fre quently becomes placed under the animal while it is in this attitude and from the cir cumstance that it does not extend beyond the extremity of the i chial tuberositie it seems as if the tail originally had been bent round by the will of the animal into the interspace be tween the callosities to escape being pressed between them and the ground and that in time the curvature became permanent fitting in of itself when the organ happens to be sat upon Under these circumstances it is not surprising that the surface of the tail should have been roughened and rendered callous and Dr Murie[33] who carefully observed this species in the Zoological Gardens as well as three other closely allied forms with slightly longer tails says that when the animal sits down the tail is necessarily thrust to one side of the buttocks and whether long or short its root is consequently liable to be rubbed or chafed As we now have evidence that muti lations occasionally produce an inherited ef fect[4] it is not very improbable that in short tailed monkeys the projecting part of the tail being functionally useless should after many generations have become rudimentary and distorted from being continually rubbed and chafed We see the projecting part in this con dition in the *Macacus brunneus* and absolutely aborted in the *M ecaudatus* and in several of the higher apes Finally then as far as we can judge the tail has disappeared in man and the anthropomorphous apes owing to the terminal

as to become suitable to the erect or semi erect position

I have now endeavoured to shew that some of the most distinctive characters of man have in all probability been acquired either di rectly or more commonly indirectly through natural selection We should bear in mind that modifications in structure or constitution which do not serve to adapt an organism to its habits of life to the food which it consumes or passively to the surrounding conditions, can not have been thus acquired We must not however be too confident in deciding what modifications are of service to each being we should remember how little we know about the u e of many parts or what changes in the blood or tissues may serve to fit an organism for a new climate or new kinds of food Nor must we forget the principle of correlation by which as Isidore Geoffroy has shewn in the case of man many strange deviations of struc ture are tied together Independently of cor relation a change in one part often leads through the increased or decreased use of other parts to other changes of a quite unexpected nature It is also well to reflect on such facts as the wonderful growth of galls on plants caused by the poison of an insect and on the remarkable changes of colour in the plumage of parrots when fed on certain fishes or inocu lated with the poison of toads[35] for we can thus ee that the fluids of the system if altered for some pecial purpose might induce other changes We should e pecially bear in mind that modifications acquired and continually used during past ages for some useful purpose would probably become firmly fixed and might be long inherited

Thus a large yet undefined extension may safely be given to the direct and indirect re sults of natural selection but I now admit after reading the essay by Nageli on plants and the remarks by various authors with re spect to animals more e pecially tho e recently made by Professor Broca, that in the earlier editions of my *Origin f Species* I perhaps at tributed too much to the action of natural selection or the survival of the fitte t I have alte d the fifth edition of th *Origin* so as to confine my remarks to adapti e hai ges of structure but I am con ine d from the light gained luring ven the la t fe years, that very many structures which no v appear to us useles ill lereafter be pro l to be useful and will therefore come with in the range of natural selection Nevertheless, I did not for

e tly i h t d ff t f t ot b t g tl u barbs of th ir own t il f th ee b th ge e al s bject *Variat f l m ls d I la ts under Domestical o i,* ol i pp 22 24

[35] *Th l m t o i f l mals d I l ts der Domest cat o* v l. u pp 250 282

CHAPTER III

COMPARISON OF THE MENTAL POWERS OF MAN AND THE LOWER ANIMALS

We have seen in the last two chapters that man bears in his bodily structure clear traces of his descent from some lower form; but it may be urged that, as man differs so greatly in his mental power from all other animals, there must be some error in this conclusion. No doubt the difference in this respect is enormous, even if we compare the mind of one of the lowest savages, who has no words to express any number higher than four, and who uses hardly any abstract terms for common objects or for the affections, with that of the most highly organised ape. The difference would, no doubt, still remain immense, even if one of the higher apes had been improved or civilised as much as a dog has been in comparison with its parent form, the wolf or jackal. The Fuegians rank amongst the lowest barbarians; but I was continually struck with surprise how closely the three natives on board H. M. S. *Beagle*, who had lived some years in England, and could talk a little English, resembled us in disposition and in most of our mental faculties. If n

My object in this chapter is to shew that there is no fundamental difference between man and the higher mammals in their mental faculties. Each division of the subject might have been extended into a separate essay, but must here be treated briefly. As no classification of the mental powers has been universally accepted, I shall arrange my remarks in the order most convenient for my purpose; and will select those facts which have struck me most, with the hope that they may produce some effect on the reader.

With respect to animals very low in the scale, I shall give some additional facts under Sexual

als of the same species is an important point for us, and some few illustrations will here be given. But it would be superfluous to enter into many details on this head, for I have found on frequent enquiry, that it is the unanimous opinion of all those who have long attended to animals of many kinds, including birds, that the individuals differ greatly in every mental characteristic. In what manner the mental powers were first developed in the lowest organisms,

ence of this kind. We must also admit that there is a much wider interval in mental power between one of the lowest fishes, as a lamprey or lancelet, and one of the higher apes, than between an ape and man; yet this interval is filled up by numberless gradations.

Nor is the difference slight in moral disposition between a barbarian, such as the man described by the old navigator Byron, who dashed his child on the rocks for dropping a basket of sea-urchins, and a Howard or Clarkson; and in intellect, between a savage who uses hardly any abstract terms, and a Newton or Shakespeare. Differences of this kind between the highest men of the highest races and the lowest savages, are connected by the finest gradations. Therefore it is possible that they might pass and be developed into each other.

See the evidence on those points, as given by Lubbock, *Prehistoric Times*, p. 354, &c.

As man possesses the same senses as the lower animals, his fundamental intuitions must be the same. Man has also some few instincts in common, as that of self-preservation, sexual love, the love of the mother for her new-born offspring, the desire possessed by the latter to suck, and so forth. But man, perhaps, has somewhat fewer instincts than those possessed by the animals which come next to him in the series. The orang in the Eastern islands, and the chimpanzee in Africa, build platforms on which they sleep; and, as both species follow the same habit, it might be argued that this was due to instinct, but we cannot feel sure that it is not the result of both animals having similar wants, and possessing similar powers of reasoning. These apes, as we may assume, avoid the many poisonous fruits of the tropics, and man has no such knowledge; but as our domestic animals, when taken to foreign lands, and

the community though some are of secondary service to it For instance the horns of ruminants and the great canine teeth of baboons appear to have been acquired by the males as weapons for sexual strife but they are used in defence of the herd or troop In regard to certain mental powers the case as we shall see in the fifth chapter is wholly different for these faculties have been chiefly or even exclusively gained for the benefit of the community and the individuals thereof have at the same time gained an advantage indirectly

It has often been objected to such views as the foregoing that man is one of the most helpless and defenceless creatures in the world and that during his early and less well developed condition he would have been still more helpless The Duke of Argyll for instance insists[96] that the human frame has diverged from the structure of brutes in the direction of greater physical helplessness and weakness That is to say it is a divergence which of all others it is most impossible to ascribe to mere natural selection He adduces the naked and unprotected state of the body the absence of great teeth or claws for defence the small strength and speed of man and his slight power of discovering food or of avoiding danger by smell To these deficiencies there might be added one still more serious namely that he cannot climb quickly and so escape from enemies The loss of hair would not have been a great injury to the inhabitants of a warm country For we know that the unclothed Fuegians can exist under a wretched climate When we compare the defenceless state of man with that of apes we must remember that the great canine teeth with which the latter are provided are possessed in their full develop-

to survive

In regard to bodily size or strength we do not know whether man is descended from some small species like the chimpanzee or from one as powerful as the gorilla and therefore we cannot say whether man has become larger and stronger or smaller and weaker than his ancestors We should however bear in mind that an animal possessing great size strength and ferocity and which like the gorilla, could defend itself from all enemies would not perhaps have become social and this would most effectually have checked the acquirement of the higher mental qualities such as sympathy and the love of his fellows Hence it might have been an immense advantage to man to have sprung from some comparatively weak creature

The small strength and speed of man his want of natural weapons &c are more than counterbalanced firstly by his intellectual powers through which he has formed for himself weapons tools &c though still remaining in a barbarous state and secondly by his social qualities which lead him to give and receive aid from his fellow men No country in the world abounds in a greater degree with dangerous beasts than southern Africa no country presents more fearful physical hardships than the arctic regions yet one of the puniest of races that of the bushmen maintains itself in southern Africa as do the dwarfed Esquimaux in the arctic regions The ancestors of man were no doubt inferior in intellect and probably in social disposition to the lowest existing savages but it is quite con

such as that of climbing trees &c But these ancestors would not have been exposed to any special danger even if far more helpless and defenceless than any existing savages, had

natural selection arising from the competition of tribe with tribe in some such large area as one of these together with the inherited effects of habit, would under favourable conditions have sufficed to raise man to his present high position in the organic scale.

[96] *Primeval Man*, 1869 p 66

ce

perf rmed by the l r animals, nam is tn t man ann t, n hi fir t trial mak f in tance ton h tch t r canoe th gh h po f imitati n. H has to l arn h w k ... ce h ... th oth l d can

h ld and p n ced

T return t mmed bject th l animals, l k man m nifestly feel pl asure and pain, h pp n ss nd misery H pp es bett xhib ted th b y ung

scribed b th t ll t bserv P H b wh w ants chas g and pret d g to b te each th lik so man p pp s.

Th fact th t th l w anim ls are cited by tl sam m ti ns as rsel so w ll established, that t will t b n cessary to w ary th read by many d ta l T rro acts in th sam mann th m as using th muscl to tr mbl th heart t palp tat th plunct rs to b laxed and th l ai t stand end Susp n, th ff p in ff ar em tly haracteri t f m t wild animals. It s, I think, mposs bl to read th account

taml nh nted E ry kn l w l bl animals are to f m g and h w plai l th l w t Man and p babl tru anec d t h bee p bli hed th l g-d l yed nd artful re g f an nimals. Th accu te Rengg and B hm tat that th Am n and African m nk y whi h th y

Lept tam cert nly r v ged tl emselve S r Andr w Smith a zool g t wh se scrup l us acc acy was kn n t m y p rsons, told me th f ll w g f y f wh ch h was l mself an y w tn ss t the C pe f Good H pe an ffice had ft n pla ed a certain b boo and th nimal se h m pp ach ng e S d y f r par d po ed wate nto h le nd hast l mad some tl k m d wl ch h skil fully dasl ed o th officer as h passed by to the musement f many by tand F r l ng aft rward tl b boo r j ced and triumphed wh h saw l s ict m

Th l f ad g f h mast i n t n us as an ld writ q tly s ys, A d g is the only thi g n thi earth that l v y m re

ss tu p

crease f kn ledge, r unl ss l l ad a h art f t u t h f lt rem rse t th

in th tw cases W see m t al affect n hib ted th m t trifl g d tal l th R g bse ed Am n an m k (a Cebu.) ca fully dri ing w y th fl wl h pl gued l r nfant and D cel saw Hy lobates washi th fac f h y ung n a t m. So tense th gri f f l m l m n k y f th l ss f th y g th t t bly ca sed th d th f certain ki d k pt u d confin m t by B hm N Afri a. Orphan m nk y w re alw ys ad pted d arefully guarded b th th m nk ys, both mal and f males. O f m l b boon h d so capaci a h art tl t h t nly ad pted y un m nk y f the pec s, b t tol y g d gs and ts, which h co t n lly carried abo t. H ki dn ss ho d d n t g so far as to hare h food w tl h ad pted ff pri g, t which Brehm was rprised as his m nk l y d ded ry tl g q t fai ly w tl thei wn y g s. An ad pted kitt se t hed thi affect nate baboon who

1 All the f ll g t t m ts, ... ll th y f these t natural ts, re take from Re g Nat rg sch. der ... gethier von ... y 1830 ss. 41-57 and from Brehm Thierlebe B ... ss. 10-87

when first turned out in the spring often eat poisonous herbs which they afterwards avoid we cannot feel sure that the apes do not learn from their own experience or from that of their parents what fruits to select It is however certain as we shall presently see that apes have an instinctive dread of serpents and probably of other dangerous animals

The fewness and the comparative simplicity of the instincts in the higher animals are remarkable in contrast with those of the lower animals Cuvier maintained that instinct and intelligence stand in an inverse ratio to each other and some have thought that the intellectual faculties of the higher animals have been gradually developed from their instincts But Pouchet in an interesting essay has shewn that no such inverse ratio really exists Those insects which possess the most wonderful instincts are certainly the most intelligent In the vertebrate series the least intelligent members namely fishes and amphibians do not possess complex instincts and amongst mammals the animal most remarkable for its instincts namely the beaver is highly intelligent as will be admitted by every on

ng to Mr Herbert Spencer [4] have been developed through the multiplication and co-ordination of reflex actions and although many of the simpler instincts graduate into reflex actions and can hardly be distinguished from them as in the case of young animals sucking yet the more complex instincts seem to have originated independently of intelligence I am however very far from wishing to deny that instinctive actions may lose their fixed and untaught character and be replaced by others performed by the aid of the free will On the other hand some intelligent actions after being performed during several generations become converted into instincts and are inherited as when birds on oceanic islands learn to avoid man These actions may then be said to be degraded in character for they are no longer performed through reason or from experience But the greater number of the more complex instincts appear to have been gained in a wholly different manner through the natural selection of variations of simpler instinctive actions Such variations appear to arise from the same unknown causes acting on the cerebral organisation which induce slight variations or individual differences in other parts of the body and these variations owing to our ignorance are often said to arise spontaneously We can I think come to no other conclusion with respect to the origin of the more complex instincts when we reflect on the marvellous instincts of sterile worker ants and bees which leave no offspring to inherit the effects of experience and of modified habits

Although as we learn from the above mentioned insects and the beaver a high degree of intelligence is certainly compatible with complex instinct

tion yet it is not improbable that there is a certain amount of interference between the development of free intelligence and of instinct,—which latter implies some inherited modification of the brain Little is known about the functions of the brain but we can perceive that as the intellectual powers become highly developed the various parts of the brain must be connected by very intricate channels of the freest intercommunication and as a consequence each s t would

swer to

a def

—man

There seems even to exist some relation between a low degree of intelligence and a strong tendency to the formation of fixed though not inherited habits for

this is encouraged

I have thought this digression worth giving because we may easily underrate the mental powers of the higher animals, and especially of man when we compare their actions founded on the memory of past events on foresight, reason and imagination with exactly similar actions instinctively performed by the lower animals in this latter case the capacity of performing such actions has been gained step by step through the variability of the mental organs and natural selection without any conscious intelligence on the part of the animal during each successive generation No doubt as Mr Wallace has argued [5] much of the intel

[1] L Instinct chez les insectes Revue des Deux Mondes Feb 18 p 690

The Amer B er and His W 1868

[4] The Principles of Psychology 2nd ed 18 0 pp 418–443

[5] Contributions to the Theory of Natural Selection 18 0 p 212

snake in p per b g, w th th mo th loosely losed f th larg comp rtm ts. On of th m nk y mmed tely pproa hed u ti usly pe ed th bag a little, peeped n, and instantly dashed w y Th n I tnessed what Brehm has described, fo m nkey afte m n k y with head raised h gh and turned n sid could not esist taki g a m me tary peep into the pright b g, at th dreadf l bject l y g qui tly t the bott m It wo ld almo t ppear as if m nk s had some ti n f o-l gical affinit s, f tl se k pt by Brehm xl b ted t ang th ugh ini tak n, instin ti dread f innoce t lizards and f gs. An rang, lso has been kn wn to b m ch alarmed t th first ght f a t rtl u

Th principl f *Imit tion* tro g in man, and especially as I h myself bserved with sa ages. In certain m b d tat f th b ain this t den y is gg rated to an t aordi nary d gree som h mipl g c p tient and thers, t th comm ncem t f inflammat ry soft m g f th brain, unco iscı sly im tate ry rd which tt red, wh tl r n tl n f gn langu g and ery g ture acti wh ch is perf med n th m D sor[4] has remarked th t animal l n tarily imitate an act n pe f rmed by man, t l in th asce d g scale w come to m n k ys, hich ar w ll kn n to be d c l us mock s. Animals, h som tim m tat each th act ns th t pec es f l res, hich had bee reared by d gs, l arned

an l p rrots re t m tato f any w l wh l th ft l ar D d la M ll n an acco t f a d re d by a cat wl l t to m t t tl ll kn wn ac t f cat l ki g l p s, d th wash h rs ar d face this was lso w t essed b th cel b ted nat l t A d I l rec ed se l co fi m t y acco t in e f these d g, l ad t bee kled b cat, b t had bee bro ght p th t th ll k ttens, and had thus q ired th abo

habit, wl ch h v r afterward pr ctised dur ing hi f l tee y ars Dure u de l Mall pl y w f rep assure he paws into j b mo th f r h r head A kitte f th cat soon learned th same tr ck, and practised t e er aft rwards, when r there was an ppo t ty

m re petion w tend nci s, m y be said to ed cat th m. We see thi wh n cat bri gs a h mouse to l kittens and Dure u d la Malle has gi n a curi acco t (in the p pe above quoted) of his observations n hawks which ta ght their y ng d terity as w ll as judgm nt of di tances, by first d pping through th air d ad mice and parrows, which th young ge erally failed t cat h and tl en bri gi g th m li birds and l tt g th m loose.

Hardly any faculty m re important f th tellect al progress f man than *Attention* Animals cl arl manifest this powe as wh n a cat w tcl es by a hol and prepares t pri g n t prey Wild animals sometim becom so bso bed wh n th s e g ged th t th y may be eas ly pproached M Bartlett has gi n m a rious proof h w ari bl thi faculty is i m nk ys. A man who t ains m n key to act pl s, used t purchase common kinds from th Zoolo cal Soc ty t th price f fi pounds f ach b t l e ff red to gi d bl tl price, f l m ght keep three r f u f th m f f w d rd t select n Wh asked h w h co ld poss bly learn so soon, wh th parti la m nk y w ul l turn

k y its att t was eas ly d tracted as by a fly th wall ll trifl g l ject the case was h peless. If h tr ed by p hm t to mak an in tte ti e m nk y act, it tur ed lky On tl th hand a m nk y which caref lly tt ded to him co ld alw y be trai ed

It s lmost perfl s t tate th t animals ha e cell t *Mem ries* f perso s and places A baboo t tl C pe f Good H pe, as I h bee f rmed by S A d w Smith recog nised l m w th j y aft an bse ce f nine m ths. I had a d who was sa ag and a erse

W C L Martin, *Nat al H story of M mmalia*, 1 41 p 405

1 B man *O Aphas a*, 18 p 110

[4] ted by Vogt, *Mémoi le M crocéphale* 1S6 p. 168.

Th Variatio of A mals nd Pla ts nder Domestication, vol i., p. 2

Annales de Scienc Nat., (1 t series), tom. xxii., p. 397

certainly had a fine intellect for she was much astonished at being scratched and immediately examined the kitten s feet and without more ado bit off the claws [11] In the Zoological Gardens I heard from the keeper that an old baboon (*C chacma*) had adopted a Rhesus monkey but when a young drill and mandrill were placed in the cage she eemed to perceive that these monkeys though distinct species were her nearer relatives for she at once rejected the Rhesus and adopted both of the young drill and mandrill whenever it could do so with safety this conduct exciting great indignation in the old baboon Monkeys will also according to Brehm defend their master when attacked by any one as well as dogs to whom they are attached from the attacks of other dogs But we here trench on the subjects of sympathy and fidelity to which I shall recur Some of Brehm s monkeys took much delight in teasing a certain old dog whom they disliked as well as other animals in various ingenious ways

Most of the more complex emotions are common to the higher animals and ourselves Every one has seen how jealous a dog is of his master s affection if lavished on any other creature and I have observed the same fact with monkeys This shews that animals not only love but have desire to be loved Animals manifestly feel emulation They love approbation or praise and a dog carrying a basket for his master exhibits in a high degree self complacency or pride There can I think be no doubt that a dog feels shame as distinct from fear and something very like modesty when begging too often for food A great dog scorns the snarling of a little dog and this may be called magnanimity Several observers have stated that monkeys certainly dislike being laughed at and they sometimes invent imaginary offences In the Zoological Gardens I saw a baboon who always got into a furious rage when his keeper took out a letter or book and read it aloud to him and his rage was so violent that as I witnessed on one occasion he bit his own leg till the blood flowed Dogs shew what may be fairly called a sense of humour as distinct from mere play if a bit of stick or other such object be thrown to one he will often carry it away for a short distance and then squatting down with it on the ground close before him will wait until his master comes quite close to take it away The dog will then seize it and rush away in triumph repeating the same manœuvre and evidently enjoying the practical joke

We will now turn to the more intellectual emotions and faculties which are very important as forming the basis for the development of the higher mental powers Animals manifestly enjoy excitement, and suffer from ennui as may be seen with dogs and according to Rengger with monkeys All animals feel *Wonder* and many exhibit *Curiosity* They sometimes suffer from this latter quality as when the hunter plays antics and thus attracts them I have witnessed this with deer and so it is with the wary chamois and with some kinds of wild ducks Brehm gives a curious account of the instinctive dread which his monkeys exhibited for snakes but their curiosity was so great that they could not resist from occasionally satiating their horror in a most human fashion by lifting up the lid of the box in which the snakes were kept. I was so much surprised at this account that I took a stuffed and coiled up snake into the monkey house at the Zoological Gardens and the excitement thus caused was one of the most curious spectacles which I ever beheld Three pecies of Cercopithecus were the most alarmed they dashed about their cages and uttered sharp signal cries of danger which were understood by the other monkeys A few young monkeys and one old Anubis baboon alone took no notice of the snake I then placed the stuffed specimen on the ground in one of the larger compartments After a time all the monkeys when a wooden ball with which they were familiar as a plaything was accidentally moved in the straw under which it was partly hidden they all instantly started away These monkeys behaved very differently when a dead fish a mouse [12] a living turtle and other new objects were placed in their cages for though at first frightened they oon approached handled and examined them I then placed a live

[12] I ha e g e a h t acco nt f th r beha r n th occa n my *Exp f the Emotions n M and A al* p 43

large plate-glass wind w w re to dash himself ev n nce against t, h wo ld f a l g time aft rwards associate a hock with wind w fram b t erv diff re tly from th p k he w uld probably reflect n th n t re f the impedim t, and be ca t under analo us circumstances. N w with m k s, as w shall prese ll see, painf l r m rely a disagreeabl impressi n, from an act n ce per f m m suffi t to pre e t th

ase of man that similar diff re ce mp es th possessio of a fundam tally diff re t mi d

H uzea relates that, whilst crossin wid and arid plain in Texas, h tw d g s ff red gre tly from thirst, and th t between th ty and f rty tim th rushed d wn th h ll ws t search f w t These h ll ws w re n t all s, and th re w re tree in th m an th diff rence th g tat n, and as th re absol t l dry th re co ld b been m ll of damp arth. Th d gs beha ed as if th y kn w that d p th gro d ff red th m th best chance f fin ling t and H uz has ft tnessed th sam beha ur in th animals.

I h seen, as I daresa h th rs, th t h small bject thro n th gro d be d th reach f f th l pl ts n th Zool gical Gard ns, h bl w thro gh his trunk th gro nd bey nd th bject, so that th curre t reflected all sid may dri th bject withi his reach. A ain w ll kn n th logist, M W tropp inf rm m th t h observed in V nna bear d l b t ly m kin th his paw rre t som w t which as close t th bar f hi cag so as to draw p ece of floati g bre d th hi reach. These act ns f th l phant and bear can hardl be ttrib ted t in t t nl ted hab t, as th y ld be f littl use t an mal in tat f nat re N w what th diff re ce between h actions, when pe formed b an ncult ted man, and by th h gh animals

Th sa and th d g h ft f d t at low l l, and th co ncid ce d h circumstances has becom associ ted in

them mi ds. A culti ated man w uld pe haps make som g e al proposition on th ubject but from all th t w kn w f sa a es t i ex trem l l btf l wh ther they would do so, and a d g certainly w uld n t. B t a sa age d w ll se rch t th sam w y

conse usly pla
w uld ppl t th e el pl ant and th bear m k g rent in the r w t Th sav ll certai l ne the kno n u are by

inl sl g t ham f ded t ns There w uld n d bt be thi diff re ce b t ee h m and f th h gl an mals, that h w uld take n tice f m cl l ght r circum tances and co d ti ns, nd w ld obse any con ect n betw th m ft m ch l ss xpen ce and

n ss, w th l cl all sorts f bjects and sounds

exactly th sam w y thi pow of assoc ti from th se l w n th scal ch as th pike, as w ll as in th t of draw g inf renc and f bse ti

Th prompt f reason, aft r y sh t experi nce, are w ll sh wn by the f ll w ac ti ns f Am rican m nk ys, wl ch tand l w in th rd It gg a m t caref l observ t tes th t wh n l first g gg to his m nk y m l ar gu they mashed th m, and th s l t m ch f th co t nts aft ward th y g tl hit d gainst som hard bod and p led ff th b ts of sh ll w th th fing rs Aft cutting th msel es l ce with any harp tool th y ld n t t h t am, w ld handl t w th th gre t t ca t n. L mp f gar w ft n gi n th m wrapped p in p pe and R gg som tim p t l wa p th p pe so that in hastily

Etude sur le Facultés Mentale des Anim ux, 18 t, om. ii. p. 265.

*Prof H xl y has nal sed with admirabl cl rness th m tal t ps by hich man, as ll as d g arri a concl in case nal gous t that gi my t t. See his art le Mr D rw Crit cs, the C ntempor y Rev ew N 18 1 p. 462, nd in his Crit q nd Essay 18 3 p 2 9

to all strangers and I purposely tried his memory after an absence of five years and two days I went near the stable where he lived and shouted to him in my old manner he shewed no joy but instantly followed me out walking and obeyed me exactly as if I had parted with him only half an hour before A train of old associations dormant during five years had thus been instantaneously awakened in his mind Even ants as P Huber[18] has clearly shewn recognised their fellow ants belonging to the same community after a separation of four months Animals can certainly by some means judge of the intervals of time between recurrent events

The Imagination is one of the highest prerogatives of man By this faculty he unites former images and ideas independently of the will and thus creates brilliant and novel results A poet as Jean Paul Richter remarks[19] who must reflect whether he shall make a character say yes or no—to the devil with him he is only a stupid corpse Dreaming gives us the best notion of this power as Jean Paul again says The dream is an involuntary art of poetry The value of the products of our imagination depends of co

ay combination and to a certain extent on our power of voluntarily combining them As dogs cats horse and probably all the higher animals even birds[20] have vivid dreams and this is shewn by their movements and the sounds uttered we must admit that they possess some power of imagination There must be something

d baying All dogs do not do so and according to Houzeau[21] ... not then ... nt near ... imagi ... lines of ... b fore ... ir feel

the faculties of the human mind it will I presume be admitted that *Reason* stands at the summit Only a few persons now dispute that animals possess some power of reasoning Animals may constantly be seen to pause deliberate and resolve It is a significant fact that the more the habits of any particular animal are studied by a naturalist the more he attributes to reason and the less to unlearnt instincts[22] In future chapters we shall see that some ... in ... unt ... he ... at

For instance Dr Hayes, in his work on *The Open Polar Sea* repeatedly remarks that his dogs instead of continuing to draw the sledges in a compact body diverged and separated when they came to thin ice so that their weight might be more evenly distributed This was often the first warning which the travellers received that the ice was becoming thin and dangerous Now did the dogs act thus from the experience of each individual or from the example of the older and wiser dogs, or from an inherited habit that is from instinct This instinct, may possibly have arisen since the time long ago when dogs were first employed by the natives in drawing their sledges or the arctic wolves, the parent stock of the Esquimaux dog may have acquired an instinct impelling them not to attack their prey in a close pack when on thin ice

We can only judge by the circumstances under which actions are performed whether they are due to instinct or to reason or to the mere association of ideas this latter principle however is intimately connected with reason A curious case has been given by Prof Möbius[23] of a pike separated by a plate of glass from an adjoining aquarium stocked with fish and who often dashed himself with such violence against the glass in trying to catch the other fishes, that he was sometimes completely stunned The pike went on thus for three months but at last learnt caution and ceased to do so The plate of glass was then removed but the pike would not attack these particular fishes though he would devour others which were afterwards introduced so strongly was the idea of a violent shock associated in his feeble mind with the attempt on his former neighbours If a savage who had never seen a

... p 136
[20] *Ibid* 1872, t m i p 181

... 1873 p 11

larg plat glass and w w t to dash himself e nce against t, h n ld f l ng tim aft rwards associ t shock w th a w ndow fram b t ry diff ntly from th p k he uld probably reflect n tl e t ire f the mpedim t, and be t und anal g us circumstances. N w with m nk y s, as w shall present! see, a paınf l r m rely a d sagree- abl impression from act n e per formed ı som tim uffi t t p e t th an mal from epe tı g t. If w ttrıb t thı d ff rence between the m k y and tl pık sol ly to th assoc tı f d as b g so m h tro g and m re persı te t ın th than th th th gh th p k ft rece ed much th m re se re) ry can w maı tam n the ase f man th t a simıl d ff re ce mpl th possessı n f f dam tally d ff rent m d

H ze relates th t, wmlst cross g w de nd and plain n T as, l two d g ff red gre tl from thirst, and th t b tween thı ty a d f rty tımes th y rushed d w th h llows t search f w t Tl e b ll w w re t d th re re n tree n th m r

tl m th best el ance f fin lıng w t ana ll has fl w tn ssed th sam be- l ur ın th animals.

I h seen, as I d resay h th rs, th t l small bject thro n th gro d t l reach f f th l pl t th

ol served I un b d l b t l m k th l p w rr t so w t wh ch as los t th b f hı cag so as t draw l ce l floatı g b d th h reach Tl ese act f tl l pha t and bear can ha ll be ttrı ted t t t nl ted hal t, as th y ld be f l ttl se t an a al tat f nat re N hat th dıff rence betw e l act ns, h per f med l cultı ted man, and by

trem l doubtf l wh th r tu y and ld not. But a sa age, as w th seem or nc consc w ld appl t tl e l pl ant and t maki g cu nts n th aı r water The sa ag w uld certaı ly n th r kn n are by wh t l w th de ed m m nts were ffected y t hıs act w uld b gu ded by a rud process f reasonı as s rely wo ld a phıl sopher ın h s l ng t chaı f ded ct s Tl re w uld l ff re l etween h n and

tween th m aft m h less expe thı f n am t ımportance I k pt a d l fants, old a was ness, w th wh h all so ts w re assoc ted t g tl r ın l s m d com pared w tl tl t f tl e m t nt ll t d g l e kn n But tl h h anım l d ff ın actly tl sam w y n th pow of assoc n from th l w n th scal h as th p k as w ll as th t f d w ng ınference and f bse t n

The promptı s f aso lt r ry h t men re re w ll bewn by tl f ll wı g ac

d th l t m h f th r co t nts aft

ca t L mp f gar w lt ng n th m w pped up ın p pe and It gg som t m H t h ma p n th p pe so that n hastily

F ud sur le Facultè Mentale des Anım ux l 2, tom p 265

p. 462, nd hıs Crıt q d E y 18 3 p.

unfolding it they got stung after this had *once* happened they always first held the packet to their ears to detect any movement within [26]

The following cases relate to dogs Mr Colquhoun[27] winged two wild-ducks which fell on the further side of a stream his retriever tried to bring over both at once but could not succeed she then though never before known to ruffle a feather deliberately killed one brought over the other and returned for the dead bird Col Hutchinson relates that two partridges were shot at once one being killed the other wounded the latter ran away and was caught by the retriever who on her return came across the dead bird she stopped evidently greatly puzzled and after one or two trials finding she could not take it up without permitting the escape of the winged bird she considered a moment then deliberately murdered it by giving it a severe crunch and afterwards brought away both together This was the only known instance of her ever having wilfully injured any game Here we have reason though not quite perfect for the retriever might have brought the wounded bird first and then returned for the dead one as in the case of the two wild ducks I give the above cases as resting on the evidence of two independent witnesses and because in both instances the retrievers after deliberation broke through a habit which is inherited by them (that of not killing the game retrieved) and because they shew how strong their reasoning faculty must have been to overcome a fixed habit

I will conclude by quoting a remark by the illustrious Humboldt.[28] The muleteers in S America say I will not give you the mule whose step is easiest but *la mas racional* —the one that reasons best and as he adds this popular expression dictated by long experience combats the system of animated machines better perhaps than all the arguments of speculative philosophy Nevertheless some writers even yet deny that the higher animals possess a trace of reason and they endeavor to explain away by what appears to be mere verbiage [29] all such facts as those above given

It has I think now been shewn that man and the higher animals especially the primate have some few instincts in common All have the same senses, intuitions, and sensations —similar passions affections and emotions, even the more complex ones, such as jealousy suspicion emulation gratitude, and magnanimity they practise deceit and are revengeful they are sometimes susceptible to ridicule and even have a sense of humour they feel wonder and curiosity they possess the same faculties of imitation attention deliberation choice memory imagination the association of ideas and reason though in very different degrees The individuals of the same species graduate in intellect from absolute imbecility to high excellence They are also liable to insanity though far less often than in the case of man [30] Nevertheless, many authors have insisted that man is divided by an insuperable barrier from all the lower animals in his mental faculties I formerly made a collection of above a score of such aphorisms, but they are almost worthless, as their wide difference and number prove the difficulty if not the impossibility of the attempt. It has been asserted that man alone is capable of progressive improvement that he alone makes use of tools or fire domesticates other animals, possesses property that no animal has the power of abstraction or of forming general concepts, is self-conscious and comprehends itself that no animal employs language that man alone has a sense of beauty is liable to caprice has the feeling of gratitude mystery &c believes in God or is endowed with a conscience *I will hazard a few remarks on the* more important and interesting of these point

Archbishop Sumner formerly maintained[31] that man alone is capable of progressive improvement. That he is capable of incomparably

clearly shew that this anim l p ss sed som re son ing po er

[27] *The Moor* nd *L Loch*, p 45 C l Hutchins n case f reas ng on *Dog B eak g* 1850 p 46

[28] *Per o al N rrat v* E g tr nslat v l m p 106

[29] See Mad ss n A als, by Dr W La l r La dsay in *J rnal f Mental Sci nce* July 18 1

[31] Q ted by S r C Ly ll *Ant q ty f M n*, p. 497

gre te and m re rap d impro m t than a
any oth r animal admits of no di p t and a
this s mainly d to h power f peaking and l
handing d wn h acquired kn wled With t
animals, looking first t the i di d al, ery
e who has had any xperi nce n settin
traps, kn w that v ung animals can be
ca ght m ch mo asily than ld nes and
th y can be m ch m re easily pproached by
an en my E n with respect to ld animals, t
is mpossible to catch many in th sam place
and in th sam kind f t p or t destroy
th m by th sam ki l f poison y t t im
probabl that all sh ld h partak n f the
poison, and impossibl tl t all sh uld ha e
bee ca ght in trap Th y must learn ca ti n
by seeing thei brethren ght poisoned In
N rth Am rica, wh re th fur b ari g animals
ha n re ed th y hib t, accord

ca
th re so l g carrie n, ...
possibly h com t pl y I h ece ed
se ral accounts th t wh n tel gr phs are first
set p any district, many b rd kill them
sel es by flyin against th wires, b t th t in
th course f a ry few years they l arn to
d this dang by seeing, as i w ld p-
pear thei com ad killed[22]

If w look to ccessi ge rations, to
the race th re is d bt th t b rd and th
animals g adually both acq re nd l se cau
tio relati to man tl nes[23] and
thi ti is ce tainly in chi f part an in
h rited hab t instinct b t part th re ult
of nd id al xperi nce A good observ Le-
roy[24] tates, that d tri ts h re f es are
m h h ted th g, first l g their
b rrows, are inco t tably m ch mo wary
tl an th ld n distri ts wh re th y are
not m h dist bed

Our d mest d gs ar d scended f m
l es an l jackals,[25] and th gh th y m y t
ha gai ed cunni g, and m y l lo t in
war ess and usp n, y t th y h pro-
gressed in certai m al q lit es, ch as

a o the mamma ... ttributes
who desc bes these tw latter case ... t o r the large
t

th hab tual rcise of all its ...
a di g xtirpati n by man as w ll as to
n arly all th less unn ng w ak mi ded
ats ha ing been conti usly de troy d by
him. It is h we r pos bl th t th success f
the commo rat may be d e to ts h ving pos-
sessed greate unnin than its fellow peci s,
bef re it becam associ ted with man. To
maintain nd pe dentl of any direct e i
de ce th t no animal d ri th course of
ages has progressed i tellect o oth r m tal
faculties, to be th q ti n f the e l
ti n of species. W h e seen that, according
to Lart t, xisting mammals bel nging to sev
eral rd rs ha e larg r b ains than th ir an

waln t, w th t e. ...
an American m nk y thu t b ak pen hard
palm ts and aft rwards f ts own ccord
d t t open the kind of nuts,

into a re ce, slip his hand to th oth nd
and use t in th proper man er as a l The
tamed el phants In ia are w ll kn wn to
break ff b anches f tree and use th m to
dri w y th fl and this sam act has been
obser ed in an l phant in tat f n tu [29]
I ha see y ung ang, wh n sh tl ght
she was g g t be wh pped co and protect
herself with blank t str w In these se
ral case t n and t cks w re mpl yed as
impl ments but th y are lik wise used as
w pons. Brehm[30] tates, n the thority of

F addi tional d ce th d t la, see M. Houzeau, *Etudes su l Facultés Mentales de Ani-m ux* ... 18 2, p 147

[23] See h re pect t b rds oceanic lands, in *J nal f Researche d g the V y g of th Be gle* 1845 p 398 *Origi f peci s, th ed., p. 198.*

[24] *Let I hil. su l'Intell g nc des A ma* now. ed. 1802, p 86

[25] See the nce this head chap. i., ol. i., ... *Var ation of A mals and Plants under Domestica on.*

Proceed g Zool gical Society 1864 p 186.

Sa ag and Wyma *Bosto Jou nal f Natural History* ol. 1843-44 p 383.

Sä gethier vo Par guay 18.0 ss. 51-56

[29] *The Ind F eld*, March 4 1871

[30] *Illustrierte Thierl ben*, B 1., ss. 9 82.

the well known traveller Schimper that in Abyssinia when the baboons belonging to one species (C gelada) descend in troops from the mountains to plunder the fields they sometimes encounter troops of another species (C *hamadryas*) and then a fight ensues The Geladas roll down great stones which the Hamadryas try to avoid and then both species making a great uproar rush furiously against each other Brehm when accompanying the Duke of Coburg Gotha aided in an attack with fire arms on a troop of baboons in the pass of Mensa in Abyssinia The baboons in return rolled so many stones down the mountain some as large l that the t and the against the ... It deserves notice that these baboons thus acted in concert M ... on three ... mpanied by ... hes and the ... with every appearance of rage causing such a shower of missiles as effectually kept us from approaching too near the tree As I have repeatedly seen a chimpanzee will throw any object at hand at a person who offends him and the before mentioned baboon at the Cape of Good Hope prepared mud for the purpose

In the Zoological Gardens a monkey which had weak teeth used to break open nuts with a stone and I was assured by the keepers that after using the stone he hid it in the straw and would not let any other monkey touch it Here then we have the idea of property but this idea is common to every dog with a bone and to most or all birds with their nests

The Duke of Argyll remarks that the fashioning of an implement for a special purpose is absolutely peculiar to man and he considers that this forms an immeasurable gulf between him and the brutes This is no doubt a very important distinction but there appears to me much truth ... that

... its ... rom this step it would be a small one to break the flints on purpose and not a very wide step to f...

... of time which elapsed before the men of the neolithic period took to grinding and polishing their stone tools In breaking the flints, as Sir J Lubbock likewise remarks, sparks would have been emitted and in grinding them heat would have been evolved thus the two usual methods of obtaining fire may have originated The nature of fire would have been known in the ...

... for themselves temporary platforms but as many instincts are largely controlled by reason the simpler ones such as this of building a platform might readily pass into a voluntary and conscious act The orang is known to cover its ...

... by throwing a straw mat over its head In these several habits we probably see the first steps towards some of the simpler arts, such as rude architecture and dress, as they arose amongst the early progenitors of man

Abstraction General Conceptions Self-consciousness Mental Individuality —It would be very difficult for any one with even much more knowledge than I possess to determine how far animals exhibit any traces of these high mental powers The difficulty arises from the impossibility of judging what passes through the mind of an animal and again the fact that writers differ to a great extent in the meaning which they attribute to the above terms, causes a further difficulty If one may judge from various articles which have been published lately the greatest stress seems to be laid on the supposed entire absence in animals of the power of abstraction or of forming general concepts But when a dog sees another dog at a distance it is often clear that he perceives that it is a dog in the abstract for when he gets nearer his whole manner suddenly changes if the other dog be a friend A recent writer remarks that in all such cases it is a pure assumption to assert that the mental act is not essentially of the same nature in the animal as in man If either refers what he perceives ... his senses to a mental concept th... ... I ... When I say to my terrier in an eager voice (and I have made the trial many times) Hi hi where is it he at once takes it as a ... n that something is to be hunted and generally first looks quickly all around and then

The Malay Archipelago vol 1 1869 p 87
Journ ... 1869 pp 1... 147
... to ... 1865 p ... &c.

Mr Hookham ... letter to Prof Max Müller ... the B... ... Nov May 1873.

rushes into th nearest thick t, to scent f r any game, b t finding n thing, sh looks up int an ghbourin tree fo squirrel. N w d t these acti ns cl arly sh w that she had i rr ral i a or concept that

th chase

consci usness. O th oth hand as Büchn r[34] has remarked, h w littl can the hard w ked wif of d graded Australian sa age wh uses rv f w abstract w rds, and cann t co t abo f ex rt h self-consc us ess, re- flect th nat re f h wn xist ce It is gen rall admitted, th t th hi h animals possess m m ry tt nti n, associ ti n, and som imaginati and reason. If these pow rs wh ch diff m h in diff rent animals, are capabl of impro ment, th re seems no great mprobability in m compl fac ltes, uch as th hi h f rms f ab tracti n, and self-consc us ess, &c., h ing been l ed thro gh th d l pm t and comb nati n f th impl es. It has been urged against the re maintained th t t mpossibl to sa t what point th asce di g scal ani mals becom capabl f ab tracti n, &c. b t who can sa t wh t this occurs ur ung hildre ? W see t l ast that ch pow rs are d loped in children by imperceptibl degrees.

Th t nimals retain their m tal indi d al t isunq est nabl Wh my vo ce wak ed trai of ld associ t ns in th mind f th before-m t d d g, h must ha retai ed his m tal individual t alth gh ry t m of hi brai had probably nd g chan e more than nce duri th int rval f fi ars. This d m ght h brought f rward th argument lat l ad anced t crush all l tionists, and said, I abid amid all m n tal moods and all mat rial hanges. Th teachi g that t ms le th ir impressi as legacies to th toms fall t th places th ha acated is co tradict ry of th tt ance f consciousn s, and th ref re f lse t t th teach necessitated by l

ti nism consequently th h pothesis is a false n

La g g.—This faculty has justly been con. d red as o f th cl f di tincti be- tween man and the lowe animals. B t man as h ghly compet nt judge Archbish p Whate- ly remarks, is n th al animal th t can make use f langu ge to xpress what is pass- ing in his mind and can u d rstand m re or less, wh t s so expressed by an th r [35] In P r th C bus a are h n xcited utt s

are und rstood y us, and so

stand o rs, as Rengg r and th rs declare. It is a m re remarkable fact that th d g si ce being d mesticated, has learnt to bark[36] n t t f fi disti ct to es. Alth gh

distin t f demand pplicati n, as wh n wishing f doo a wind w to be pened According t H uze wh paid parti lar tt nti n to th ubject, th d mestic f wl utt rs t l ast d zen significant so nds.[38]

Th habi t al use f articulat languag is, h w peculiar to man b t l uses, in com m n w th th low animals, inarti ulat cri s

of pain, f ar rprise ang tog th with thei ppropri t acti ns, and th murmur of a m th to h bel ed child are more expres- si than an w rds. That which distinguishes man from th l w animals n t th und tandin of articulate sounds, for as ry kn ws, d und rstand many w rds and se

[34] *Conférence sur la Théorie Darwinienne*, French transla 1869 p. 132.

[35] The Re J M Cann, *Anti-Darwi m*, 1869 p. 13

Quoted in *Anthropological Review* 1864 p. 158. Rengg *ibid* s. 45

[36] See my *V riatio f A mals and Plants nder Domesticatio*, ol. i., p. 27

Facult Mentale d A imaux tom ii., 18 2, p. 346-349

See discussio this subject in Mr E. B Ty lor ry t resting w k, *Researches nto the E rly History f Mankind*, 1865, chaps. ii. t

tences In this respect they are at the same stage of development as infants between the ages of ten and twelve months who under stand many words and short sentences but can not yet utter a single word It is not the mere articulation which is our distinguishing charac ter for parrots and other birds possess this power Nor is it the mere capacity of connect ing definite sounds with definite ideas for it is certain that some parrots which have been taught to speak connect unerringly words with things and persons with events [32] The lower animals differ from man solely in his al most infinitely larger power of associating to gether the most diversified sounds and ideas and this obviously depends on the high devel opment of his mental powers

As Horne Tooke one of the founders of the

not a true instinct for every language has to be learnt It differs however widely from all ordinary arts for man has an instinctive tend ency to speak as we see in the babble of our young children whilst no child has an instinc tive tendency to brew bake or write More over no philologist now supposes that any language has been deliberately invented it has been slowly and unconsciously developed by many steps [33] The sounds uttered by birds offer in several respects the nearest analogy to language for all the members of the same species utter the same instinctive cries expressive of their emotions and all the kinds which sing exert their power instinctively but the actual song and even the call notes, are learnt from their parents or foster parents These sounds, as Daines Barrington[34] has proved are no more innate than language is in man. The first attempts to sing may be compared to the imperfect endeavour in a child to babble The young males continue practising or as the bird catchers say recording for ten or eleven months Their first essays show hardly a rudiment of the future song but as they grow older we can perceive what they are aim ing at and at last they are said to sing their song round Nestlings which have learnt the song of a distinct species as with the canary birds educated in the Tyrol teach and trans mit their new song to their offspring The slight natural differences of song in the same species inhabiting different districts may be

stinctive tendency to acquire an art is not peculiar to man

With respect to the origin of articulate lan guage after having read on the one side the highly interesting works of Mr Hensleigh Wedgwood the Rev F Farrar and Prof Schleicher [35] and the celebrated lectures of Prof Max Müller on the other side I cannot doubt that language owes its origin to the imi tation and modification of various natural sounds, the voices of other animals and man's own instinctive cries aided by signs and ges tures When we treat of sexual selection we shall see that primeval man or rather some early progenitor of man probably first used his voice in producing true musical cadences, that is in singing as do some of the gibbon apes at the present day and we may conclude from a widely spread analogy that this power would have been especially exerted during the

[32] I have recei ed e eral deta led ccou t t this eff t. Admiral S r B J Sulivan wh m I k ow t be

to persons rr g nd good bye ld f ll w to tho d p rti g I could a ld eral th uch ca

[34] Hon Dain Barringt n in Ph losoph. T ac tio 1 3 p 262 See al D reau d la M ll in A n des S Nat 3rd seri s, Zoolog t m p 119

[35] On Orig f L g g by H Wedgwood

the further consequences of the act.

co rtship of the sexes,—w uld h xpressed an us m t ns, s h as l je l y tri umph,—and w ld hav se ed as a chall g t ri ls It is, th ref re probable that th mitat n f mus cal n s by art culate sounds m l m rise to w rds xp ss e f

f llow and sin e f wls gi dist t w a m gs f dang n the gro d r n the ky fr m h h (both as ll as thu d ery a t ll g ble

t tn per es bee fi t t p th f m ti f lang u g

n eu etus act d th pow f p ech B t tl el t n l t ce tl co ti ed se f l g age and th d l pm t f tl b l as n d bt bee f m mpo tant The m ntal po rs in som early prog nit f m n m t h bee m h gl ly d l ped th a y existi g pe, bef n th m t mperfect f m of speecl co ld h com to se b t w m y confid tly b l th t the co t ed use and ad ancem t f thi po w ld h re acted th m d tself by n bl g d o g t t ca y lo g t ains f th ght. A compl t f th ght can m re b rred th t tl and f w rd wh th r pok sil t, than l g al l t w th t th se f figure lg b It ppe a, also tl i an din y t ai f th ght lm l equires, tly facil tated by som f rm f la gu g f th d mb d af and bl d gi l La B dgman, was bse ed to use h fing rs wh lst dre m g \ the

l ss a l ng s ccessio f vi id and connected id as may pass through the mind with ut tl aid of any fo m of language as we m y i f r f m the m em nts f dogs d ri g th ir dre ms We ha also een tl at animals are ble to r aso to certain e te t, man f stly with ut th a d of langu g The nt m t con e ti n b tw en th b a as it is n w de l ped n us, and tl e faculty of peech is w ll hewn by th se uri us case f b ain-disease in whi h peech s pec ally affected as wh n th pow r to rem mber ub tant s s lo t

tal d ocal o gans l adin t nh ited chang s in th ir t ct re a d f n t ons, than in tl case f hand w iti wh ch depends partly on the f rm of th hand nd p tly n tl d po i ti n f th m d and handwrit g i ce t inly inh rited

S e l write m re pecially Prof Max Mull h l t ly ins ted th t th use of l ngu g impl es the pow f f ming g n l co cept d th t as no animals ar supposed t possess thi pow an mpassabl barri is f rmed b tween them d man W th r pect to anim ls, I ha al ady e d a red to

1873

so ofte q ted, by Brehm nd Re

Il ure gi es ry cu ious eco t f his b serv t us th bject his *Facultés Mentales de Anima* t m i., p 548.

See remarks th h ad by D M dsl y *The Physiology and Pathology of M nd*, 2nd ed 1868, p. 199

guage, 1873 third lecture) thus ph ism "Th re is tho ght th t rds, as littl as th are w rds th t th ght. Wh t tra g definiti must h re be g t th w rd th ught!

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the languages of distinct races of man I have given the foregoing details to shew that an in stinctive tendency to acquire an art is not peculiar to man

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[53] See om good ■ m rks on this h ad by Prof Whit ey in his *Ori ntal nd L g ist c St d* 1873 ■ 354 He observes that th d ire of comm ca t on betwe n m n is the h ing f rce which in the de el pment of la guage w rks both cons usly a d unconsciously consc usly as g rds th im m d t e l to be attained u consci usly as regards the further consequences of the act.

[54] H Dai B rri gt *I h losoph T ac tions* 17 3 p 262 See l Dure u de l M ll in *A d Sc N t* 3rd n *Zoolog* t m x p 119

[55] *O* *h O* *f L* l H W dgwood

ease f rms are con_tantly gai ing tl upper hand and th we the r uccess to th ir wn inhere t rt To these m re mportant causes f the surv al f certai w rds, m re m be added f th re

Th perfectl regular and w n ple l rr r of man ha a gu ti of th ir f und rs. Th F on Schl g l writes In those langu g which ppear to be t th l w t grad f t llectual ulture w freq ntl bserv erv hi h and l b- orat degree of art th gramm t al truc t re Th especiall th ase w th the Basq and th Lapponian, and man f the Am rican langu g s."[1] B t t assuredl an rro t peak f an langu g as an art n th

and as h w rd express th most b us relati ns betwee object and perso s, t is n t rpri g th t th sh ld ha bee used by th m of most races d ri g th arl t s. W th respect to perfecti tl f ll llus- t ti ll be t sh w h asil w m rr a crino d som times co ts f n l ss than 1 0 000 p eces of h ll[2] all arranged w th pe fect mm try rad t g lines b t t ralist doe t con d n animal f tl ki d as more pe fect than b lat ral w th com- parat l f w parts, and w th f these part al k cep t g th pposit sides of th bod H j tl consid rs th diff re tia tion and pecialisat f rgans as th t t of perfect n. So with langu es th most m m trical and compl ght n t t be ranked abo rregular abbre ted and bastard sed langu ges, whi h ha borrowed xpressi rd and useful f rms f constru ti n from ari co q ring, co qu red mmigrant races.

From these f w and imperfect remark I conclud th t th trem ly complex and reg ular constructi of many barbarous lan- guages, is no proof that they w thei rigin

to a seen, Itself il r an l ef th t man has been de l ped from some l we f rm

S e f B a ty —Th s sense has been de- clared i nce l t man I refe h re nly t th forms

d d ce birds, pla th bea t f l m l partne As w men e rywh re deck th msel with these plun s, th be t of u h rnaments cannot be dis- p ted As w shall ee lat r the nests of humm g b rds, and the pla ing passag f bo b rds are tast full rnam ted w th gail -col ured object and th shews that th n t rece e som ki d f pl asure from th rl t of u h thi gs. With th great ma

g th seaso f lo are ce tainly adm red t y th f m l s, f which fact d nce w ll

th latt n d pl y th harm bef re th f males w ld h been thrown aw y and thi t is mpossible to dmit. Why certain bright colo rs sl uld ex t pl as re cann t, I pre m be plai ed any m re th n why certain fla rs and sce ts are gree bl b t ll b t has som thing t d with th result, f r th t wl ch i at first unpleasant t ur se ses, ult m t ly becom pl asant, and hab ts are inh rited W th re pect t so nds, H lmh ltz has plai ed t ce tain t t n ph o- l gical principl s, wh harm ni s and certain cad nces are gree bl B t besid s this, sound freq tl recu ring t i regular inter als are highl disagree bl as ery n will adm t wh has list ned t night to th irregu lar flappin of a rope on board ship. The same

[1] Quoted by C S. Wak Chapters on M n, 1868, p. l l

[2] Buckland, Bridgewater Treatise p. 411.

[3] There som good remarks th simplificat f languages, by ir J Lubbock, Orig of C vilisation, 18 0, p. 2 8.

shew that they have this power at least in a rude and incipient degree As far as concerns infants of from ten to el ... nd ... iat ... ds ... general ideas as quickly as they do unless such ideas were already formed in their minds The same remark may be extended to the more intelligent animals as Mr Leslie Stephen observes[63] A dog frames a general concept of cats or sheep and knows the corre ponding words as well as a philosopher And the capacity to understand is as good a proof of vocal intelligence though in an inferior degree as the cap ... I

... other organs it is not difficult to see Ants have considerable powers of inter communication by means of their antennæ as shewn by Huber who devotes a whole chapter to their language We might have used our fingers as efficient instruments for a person with practice can report to a deaf man every word of a speech rapidly delivered at a public meeting but the loss of our hands whilst thus employed would have been a serious inconvenience As all the higher mammals possess vocal organs constructed on the same general plan as ours and used as a means of communication it was obviously probable that these same organs would be still further developed if the power of communication had to be improved and this has been effected by the aid of adjoining and well adapted parts namely the tongue and lips[64] The fact of the higher apes not using their vocal organs for peech no doubt depends on their intelligence not having been sufficiently advanced The possession by them of organs which with long continued practice might have been used for peech although not thus used is paralleled by the case of many birds which possess organs fitted for singing though they never sing Thus the nightingale and crow have vocal organs similarly constructed these being used by the former for diversified song and by the latter only for croaking[65] If it be asked why apes have not had their intellects developed to the same degree as that of man general causes only can be as igned ... or development through which each creature has passed

The formation of different languages and of distinct pecies an l the proofs that both have been develope l through a gradual process, are curiously parallel[67] But we can trace the f r mation of many words f ... t ... tinct languages striking homologies due to community of descent and analogies due to a similar process of formation The manner in which certain letters or sounds change when others change is very like corre lated growth We have in both cases the re duplication of parts the effects of long-continued use and so forth The frequent presence of rudiments both in languages and in pecies, is still more remarkable The letter *m* in the word *am* means *I* so that in the expression *I am* a superfluous and useless ru liment has been retained In the pelling also of words, letters often remain as the ru liments of ancient forms of pronunciat ... I

... to descent or artificially by other characters Dominant lang ... reappears The same language never has two birth places Distinct languages may be crossed or blended together[68] We see variability in every tongue and new words are continually cropping up but as there is a limit to the powers of the memory single words, like whole languages gradually become extinct As Max Müller[69] has well remarked — A struggle for life i con tantly going on amongst the wor ls and grammatical forms in each language The better the ...

[63] *Essays* ... F ... *Th* ... 1873 p 82

[64] See s m good remarks to this ffect by Dr M ud l y *The Phy iology nd Pathology f M nd*, 1868 p 199

[65] Ma gilli ray *H t f Brit h B ds* v l i 1839 p 29 An ... celle t bserv r Mr Bl ckw ll rem ks that the magpie l rns to pro u ce ... gl w rds, and e n sh t nte ces m re d ly than lmost any other British bird yet as h adds, aft r lo g ... d

... gy 1855 ... 8

[67] See th ... ry nt ... g par ll l m bet ee th d l ... nt f pecies and l ngu ges ... by C L y ll *Th G ol gical Evid nc* ... *f th Ant q ty f M n*, 1863 ch p x

[68] See rem ... k ... t this ffect by th R ... F W F rr r ... t ... t g art ... tled ... h l l gy nd D rw nism ... *Nat e* M rch 24 18 0 p 528

[69] *Nat* ... J nu ry 6 18 0 p ...

imagination, curiosity, reason, &c., had been fairly well d el ped in the mind of man, his dreams would not ha led him to beli ve in spirits, an more than in th case of a dog.

The tendency in savages to imagine that natural objects and agencies are animated by spiritual or living essences, is perh ps illustrated b little fact which I once noticed: my dog, a full-grown and very sensible animal, was lying on th lawn during a h t and still day but at little distance sl ght breeze occasi nally mo ed an pen parasol, which w uld have been wholly disregarded by the dog, had any one stood near t. As t was, ery tim that the parasol sl ghtl mo ed, the do growled fiercely and barked. He must, I think, have reasoned to himself in rapid and unconscious manner that mo ement without any pparent cause indicated th presence of some strange living agent, and that no stran had a right to be on his territory.

The belief in spiritual agencies would easily pass into the belief in the existence of one or more gods. For sa ages w uld naturall attribute to spirits the sam passions, th sam lo of engeance o simplest form of justice and the same affections which they themsel es feel. Th egians ppear to be in this respect in an intermediate conditi n, f when the surgeon on board the *Beagle* shot some oung ducklings as specimens, Y rk Minster d clared in the most solemn manner "Oh, Mr Bynoe, much rain, much snow blow much and this was va otl retrib ti punishment for wasting human food. So again h re lated how when his broth killed wild man, storms long raged, much rain and snow fell. Y t w could disco that the Fuegians beli ed in what w should call a God, or practised any religious rites and J mmy B tton, with justifiable pride, sto ll maintained that th re was no d vil in his land. This latter assertion is the more remarkable, as with savages the belief in bad spirits is far more common than that in good on s.

The feeling of religious d otion is a highly complex one, consisting of love, complete submission to an exalted and myst ri us , perh a strong sense of d pendence f ar rev rence gratitude, h pe fo the f ture, and perhap oth r elem nts. N being could experi nce so complex an moti n until ad anced in his intellectual and m ral faculties to at least a mod rately high le el. N erth less, w see som distant pproach to *this state of mind in* the deep lo of dog fo his master associ ted with compl te submissi n, som f ar and perhaps ther feelings. Th behaviour of a d wh n returning to hi master after an absence and, as I may add, of a monkey t his beloved keeper is wid ly differe t from that towards their f llows. In th latter case the transports of r me to be som wh t less, and the

...

long as his reasonin powers remained poorly d v loped, to vari us strange uperstitions and

...

superstitions, f they sh w us what an infinite debt of gratitud w we to th impro ement of our reason, to science, and to our accumulated knowledge. As Sir J Lubbock[7] has w ll observed, " t is not too much to say that the horrible dread of unkn wn vil hangs lik a thick cloud over savage life, and mbitters ery pleasure." These miserabl and indirect consequences of our highest faculties may be compared with th incidental and occasional mistakes of th instincts of th lowe animals.

He then further shews that names or nicknames given from some animal or other object, to the early progenitors or founders of tribe are supposed after long interval to represent the real progenitor of the tribe and such animal or object is then naturally believed still to exist as pirit, is held sacred, and worshipped as god. Nevertheless I cannot b t suspect that there is still earlier and ruder stage hen anything hich manifests power or mo eme t is thought to be ndowed with some form of life, and with mental faculties analogous to our own.

Journal of Mental Science, 1871, p. 45) that Bacon long ago, and the poet Burns, held the same notion.

[7] *Prehistoric Times*, 2nd ed., p. 571. In this work (p. 571) there will be found an excellent account of the many strange and capricious customs of savages.

principle seems to come into play with vision as the eye prefers symmetry or figures with some regular recurrence Patterns of this kind are employed by even the lowest savages as ornaments and they have been developed through sexual selection for the adornment of some male animals Whether we can or not give any reason for the pleasure thus derived from vision and hearing yet man and many of the lower animals are alike pleased by the same colours graceful shading and forms and the same sounds

The taste for the beautiful at least as far as female beauty is concerned is not of a special nature in the human mind for it differs widely in the different races of man and is not quite the same even in the different nations of the same race Judging from the hideous ornaments and the equally hideous music admired by most savages it might be urged that their æsthetic faculty was not so highly developed as in certain animals for instance as in birds Obviously no animal would be capable of admiring such scenes as the heavens at night a beautiful landscape or refined music but such high tastes are acquired through culture and depend on complex associations they are not enjoyed by barbarians or by uneducated persons

Many of the faculties which have been of inestimable service to man for his progressive advancement such as the powers of the imagination wonder curiosity an undefined sense of beauty a tendency to imitation and the love of excitement or novelty could hardly fail to lead to capricious changes of customs and fashions I have alluded to this point because a recent writer [3] has oddly fixed on Caprice as one of the most remarkable and typical differences between savages and brutes But not only can we partially understand how it is that man is from various conflicting influences rendered capricious but that the lower animals are as we shall hereafter see likewise capricious in their affections aversions and sense of beauty There is also reason to suspect that they love novelty for its own sake

Belief in God—Religion —There is no evidence that man was aboriginally endowed with the ennobling belief in the existence of an Omnipotent God On the contrary there is ample evidence derived not from hasty travellers but from men who have long resided with savages, that numerous races have existed and still exist who have no idea of one or more gods and who have no words in their languages to express such an idea [74] The question is of course wholly distinct from that higher one whether there exists a Creator and Ruler of the universe and this has been answered in the affirmative by some of the highest intellects that have ever existed

If however we include under the term religion the belief in unseen or spiritual agencies the case is wholly different for this belief seems to be universal with the less civilised races Nor is it difficult to comprehend how it arose As soon as the important faculties of the imagination wonder and curiosity together with some power of reasoning had become partially developed man would naturally crave to understand what was passing around him and would have vaguely speculated on his own existence As Mr M Lennan[75] has remarked Some explanation of the phenomena of life a man must feign for himself and to judge from the universality of it, the simplest hypothesis and the first to occur to men seems to have been that natural phenomena are ascribable to the presence in animals, plants and things and in the forces of nature of such spirits prompting to action as men are conscious they themselves possess It is also probable as Mr Tylor has shewn that dreams may have first given rise to the notion of spirits for savages do not readily distinguish between subjective and objective impressions When a savage dreams, the figures which appear before him are believed to have come from a distance and to stand over him or the soul of the dreamer goes out on its travels and comes home with a remembrance of what it has seen [76] But until the faculties of

[73] *The Spectator* Dec. 4 1869 p 1430

Th W l p f A m la d l l nt m tl

v n us gifts id ce m ies, nd ts d i v ked

behind ev ery vivid impressi n. It is cl ar that many instincts d sires, su h as th t f hunge are in their nature f sh rt durati n and aft being satisfied, are n t readil or vi vidl recalled. *Thirdly* aft th pow r of langu ge had bee acquired and th wish of t.. communit could be xpressed th com mo pinio h w each m mber ought to act f th p bl c good, w uld nat rall becom in paramou t d ree th guide to acti n. But t hould be born in mind that howe r great we ht w ma ttrib te t p bl c pini n, our regard f th pprob ti n and d sapprobation of ur f low u pend mpath which, as w shall see f rms an ssential part f th so al nstinct, and indeed ts f und t t *Lastly* hab t in th nd al w ld lt m t lv pla rt important part in guid th con duct of each m mbe f th social nstin t, t l with mpath is, lik an th m

social anim l, would gain in our supposed case as t ppears to me, som feeling f right r wro g, o a consci nce. For ach indi dual would ha an ward sense of po sessing ce tain more enduring nstincts, and oth wo l sh uld fact n, misery would be f lt, as past impressi ns w re compared during their ces- sant passage thro gh th mind In this case an inward m nit would t ll th animal th t t wo ld ha been bett to ha followed th on imp lse rath than th oth Th e course ght t h e been f llowed and tl oth ht n t th one w ld ha been ri ht nd the tl e wrong but to th se t rms I hall recur

Soci d ty — Animals of many kind are so- ci l w find d tin t species living to-

ral subord nat proposit mu t n w be dis- cussed, and som of th m t consid rabl length

It m be w ll first to premise that I d n t wish t maintain that an strictl social ani mal f ts t llect al facult es w re t becom as acti and as highl d loped as in man, would acquire exactl th sam m ral sense as ours. I th sam mann as ari animals ha som sense f be t th gh th d mire wid l differe t objects, so th might h sense of ri ht and wro g th h led b t t f llow wid l diff rent lines f cond ct. If f instance to take an xtrem case m n re re red und precisel th sam condi t n as hi -bees, th re can hardl be d bt that unmarried f males would, lik th ork bees, think t sacred d t t kill th ir brothers, and m th rs w ld tri to kill ther fert le d t rs and n o w uld think of int rferi N rth l ss, th bee any th

lo f tl d g whi h tl d returns w th int re t. E ry o must ha n ticed l w miserabl h rses, d gs, heep, &c. are wh n separated from th compani ns, and what tro g m tual affecti n th two f rm kinds,

mals and pass nsects, altho h som f th se are social and aid an th n man important w s. Tl mo t comm n mutual serv ce in th high animal is t warn o an oth f dan b mean f th united sense of all. E ry port man kn ws, as D J remarks, h w diff cult t t pproach ani mals in h rd troop. Wild h rse and cattl d not, I beli v mak an dan sign l but th attit d f an of th m who first dis- co rs an m warns th th rs. Rabb ts

Mr H. Sedgwick remarks, in able discussi bject the Academy June 15, 18.., p 231) A ective bee w ma feel sure w uld a pure t mild l so of the popular question. Judging, h wev from he hal of many or most savages, m rs he problem t f male inf ticide po

she ov looks th f ct, which she would doubtless admit, that the in tincts of the bee ha bee ac- quired for the good of the communit h goes so far as t sa that if the theory of thics l ocated in this hapt were enerall cepted I cannot b t belie that in the hour of their triumph would be so nded the knell of the virtue of mankind It is t be hoped that the belief in the permanence of virtue on this earth is not held by ma pers ns n so we k t ure

Dr Darwin ache Theori s. 101

CHAPTER IV

COMPARISON OF THE MENTAL POWERS OF MAN AND THE LOWER ANIMALS (*Continued*)

I — of those ifferences he moral s c or conscience is by far the most impor tant This sense as Mackintosh[2] remarks has a rightful supremacy over every other prin ciple of human action it is summed up in that short but imperious word *ought* so full of high significance It is the mo t noble of all the attributes of man leading him without a mo ment s hesitation to risk his life for that of a fellow creature or after due deliberation im pelled simply by the deep feeling of right or duty to sacrifice it in some great cause Im manuel Kant exclaims Duty! Wondrous thought that workest neither by fond insinu ation flattery nor by any threat but merely by holding up thy naked law in the soul and so extorting for thyself always reverence if not always obedience before whom all appetites are dumb however secretly they rebel whence thy original [3]

y

y

c passing it over and because as far as I know no one has approached it exclu sively from the side of natural history The investigation possesses also some independent interest as an attempt to see how far the study of the lower animals throws light on one of the highest psychical faculties of man

The following proposition seems to me in a high degree probable—nan

being here included would inevitably acquire a moral sense or conscience as soon as its in tellectual powers had become as well or nearly as well developed as in man For *firstly* the social instincts lead an animal to take pleasure in the society of its fellows to feel a certain amount of sympathy with them and to per form various services for them The services may be of a definite and evidently instinctive nature or there may be only a wish and readi ness as with most of the higher social animals, to aid their fellows in certain general ways. But these feelings and services are by no means extended to all the individuals of the same species only to those of the same association *Secondly* as soon as the

g or dissatis faction or even misery which invariably results as we shall hereaft r see from any unsatisfied instinct would arise as often as it was perc ived that the enduring and always pre ent social instinct had yielded to some other instinct at the time stronger but neither enduring in its nature nor leaving

the p gnant qu t Ought t tl t tle tl di p t d qu t t tl

Se fo nst. n on th s bj ct, Qu t f ges *U té de l'E pèce H m* 1861 p 21 &
D ertat o Eth al I l ph 183 p 231 &c
M taphy c f E th t anslated by J W Semple Ed bu gh 1836 p 136

is ce *Th E m* d th H 1865 p 481) d tl rs bel s th t tl n l
cequ r I I y

ad led
St B Brod It r bs rv g tl t n is cial animal (*P ychologi al E q* 1854 p 192) ks ks of M M ll

F) ans, wh wh n the r pare ts get ld r fall ill, bury them ah u

Many an mals, h we e ce tainly mp t h h d t d g r Tl s

companions M Blyth as I e anf rms m Indian ro f ed ng tw three f th i c m pam l h w bl l nd I ha heard f an anal g s ase w th th d m t cock. W m y if hoose call th se ti n m ti c t b t h asc are m ch too ar f th d el pment f any pecial instin t. I h e myself ce d g wh ne passed cat wlo lay h in bask t, d was g eat f d of his, tho t gi g h r f w l cks w th hi to gu th t of ki d f l g ad g

It m t b called ympathy th t l ad a cou ro v d g t fly t any wh trik h

was it was eally path tic t se h w per se ri gly l t ed t l k h mist s f ce d co f rt h B l m[13] tat th t wl n baboo co fin m t was p rs ed t b p n l ed th tl tried to protect him It m t h bee ymp thy n th cases bo g n l h led th b boon and Cercop tl ec t de- f d th y g com ad from th do s and th ea l I w ll gi nly tl instance f mp th t and h ro co l t, n tl e case f littl Am rican m k y Se al y rs keepe t th Zool gi l G rd l d m som deep and se rcely l led w d th pe f l wn eck, flu ted h m wl l t k ecl g tl floo by ce b boon Tl l ttl Am rican m k y wh was warm f f t l keepe f ed th sam com partm t, and as d adf lly af d f th gre t l oo A rtl ss soo as f w his fri d peril h ru hed to th r scu d

by screams and l t so di t acted th baboon th t — w ble to escape, aft as tl e s g B tl tin

I agre w th Agassiz that d g possess som thing ry l k a conscien

Dogs possess some pow r f self-command and th s doe n t appea to be wh lly tl e re s lt of f r As B ubach remarks, they w ll refrain f om te l g food in the abse ce of t Th h e long bee accepted as t t

to de th But th dri himself as Dr Hooke was as. red tan n ri h. Th f bearance u d an m g y so dreadful f a h vy anim l s a w ud rf l proof f n bl fidel ty

All anim ls h g n a body wh ch d f d ll msel tta k the nemies n ncert m t nd ed b in some d gree faithf l to ne an tl and thos th t f ll w a leade mu t

n says,[20] th t tl y can t d re e n a m m t y par t n from th h rd Tl y ar sse t all l l a d accept th comm n

th se anim ls f harm ss, w tch assid u ly f those wh lly graz g p rt h w lf

[13] J L bbock, P histori T mes 2 d ed p 446

As q ted by M L H Morgan, *The America B* er 1868, p 2 2 Capt Stansbury lso gi int rest g acco t f th m in hich y g pelican, carried w y by tro g tr am was gu led nd ncou ged ts tt mpts to ach the hore l y half doze ld b rds

As M B in tat s, Effects and t uff re sp gs from ympathy proper *Mental nd Moral Science* 1868, p 245

Illustriert Thierleben, B 1, 85

D TE pe t d e l Cl 1869 p 97

Die D t sche Art Leh 1869 s. 54

See also Hook *H mal J nals*, l 1, 1854 p 333

Brehm, *Illustrierte Th l ben*, B 1, s. 6

[20] See his trem ly t estu g paper Gre- gari us ess C ttl d M n, *Macmill Magazine*, F b 1871 p 353

stamp loudly on the ground with their hind feet as a signal; sheep and chamois do the same with their forefeet, uttering likewise a whistle. Man

nels

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monkeys acts as the sentinel, and utters cries expressive both of danger and of safety.[8] Social animals perform many little services for each other: horses nibble, and cows lick each other on any spot which itches; monkeys search each other for external parasites; and Brehm states that after a troop of the *Cercopithecus griseo-viridis* has rushed through a thorny brake, each monkey stretches itself on a branch, and another monkey sitting by, conscientiously examines its fur, and extracts every thorn or burr.

Animals also render more important services to one another: thus wolves and some other beasts of prey hunt in packs, and aid one another in attacking their victims. Pelicans fish in concert. The Hamadryas baboons turn over stones to find insects, &c.; and when they come to a large one, as many as can stand round turn it over together and share the booty. Social animals mutually defend each other. Bull bisons in N. America, when there is danger, drive the cows and calves into the middle of the herd, whilst they defend the outside. I shall also in a future chapter give an account of two young wild bulls at Chillingham attacking an old one in concert, and of two stallions together trying to drive away a third stallion from a troop of mares. In Abyssinia, Brehm encountered a great troop of baboons who were crossing a valley: some had already ascended the opposite mountain, and some were still in the valley; the latter were attacked by the dogs, but the old males immediately hurried down from the rocks, and with mouths widely opened, roared so fearfully, that the dogs quickly drew back. They were again encouraged to the attack; but by this time all the baboons had reascended the height, excepting a young one, about six months old, who, loudly calling for aid, climbed on a block of rock, and was surrounded. Now one of the largest males, a true hero, came down again from the mountain, slowly went to the young one, coaxed him, and triumphantly led him away—the dogs being too much astonished to make an attack. I cannot resist giving another scene which was witnessed by this same naturalist; an eagle seized a young Cercopithecus, which, by clinging to a branch, was not at once carried off; it cried loudly for assistance, upon which the other members of the troop, with much uproar, rushed to the rescue, surrounded the eagle, and pulled out so many feathers, that he no longer thought of his prey, but only how to escape. This eagle, as Brehm remarks, assuredly would never again attack a single monkey of a troop.[9]

It is certain that associated animals have a feeling of love for each other, which is not felt by non-social adult animals. How far in most cases they actually sympathise in the pains and pleasures of others, is more doubtful, especially with respect to pleasures. Mr. Buxton, however, who had excellent means of observation, states that his macaws, which lived free in Norfolk, took "an extravagant interest" in a pair with a nest; and whenever the female left it, she was surrounded by a troop "screaming horrible acclamations in her honour." It is

surround and stare intently on a dying or dead companion; apparently, however, as Houzeau remarks, they feel no pity. That animals sometimes are far from feeling any sympathy is too certain; for they will expel a wounded animal from the herd, or gore or worry it to death. This is almost the blackest fact in natural history, unless, indeed, the explanation which has been suggested is true, that their instinct or reason leads them to expel an injured companion, lest beasts of prey, including man, should be tempted to follow the troop. In this case their conduct is not much worse than that of the North American Indians, who leave their feeble comrades to perish on the plains; or the

[8] Mr. R. Brown in Proc. Zoolog. Soc. 1868, p. 409.
Brehm, Illustrirte Thierleben, B. i. 1864, s. 52, 79. For the case of the monkey [illegible] the old male baboons attacking the dogs, see s. 79; and with respect to the eagle, s. 56.

[9] [illegible] Journal and Magazine of Natural History, November 1868, p. 382.

others.[a] B t I cannot see how tl s w e p..ins the fact that mpath is excited in an imm a rabl stro r d gree b a bel ed, than by an indif rent pe son. Th m re si ht of su ring, ind pend ntl of lo would uf ficie t call p in us d recollect ns and associations. Th xplanation ma h m th fact that, with all animals, mpath is directed soel t wards th m mbers f th sam com munity and th ref re t w rd kn wn, and les bel ed m mbers, b t n t to all

mies.

and tl rs, no doubt feel mpath f th suf f ring of th ir wn oung, b t not f that of oth mal. W th mankind selfishness,

re arn pe

to oth rs and sympathy is m ch trength ed b hab t. In ho complex a manner this feeling m h originated as t of high importance t all those animals wh h aid and d f nd anoth t will ha been increased through natural selecti f those communi ties, which included th gre test numbe of th most mpath t m mbers, w ld fl rish best, and rear th gre test numbe f off pring.

It is, how mpossib t decid in man cases h th certai social nstinct h been acquired thro h natural selection, are th indirect result of th nstincts and facult es, such as mpath reason, exper nce and a tend ncy t mitatio or again, wh ther th y are simpl the result f lo co tin ed hab t. So remarkabl an n tinct as th placing senti nel t warn th communit of dange can hardl ha bee th indirect result of an of these faculties t must, th refore h e been rectl acquired. O th th hand, th hab t follo ed b t males of som social animals of def nding th communit and of ttacking th mies their pre in co cert, ma pe

l ted from mutu l ympath

Of th various in tin ts and hab ts, som ar m ch trong r than others that is, som th gi m re pl asure in th r performance and more distress in th ir pre ntion, than others o which is probabl quite as impo tant, th y are through nh ritance m re persist ntl f l lowed, w th t exciti g any pecial feeling of plea ure pain. W are oursel es consci us that some hab ts are m ch more difficult to cure chan than th rs. H nce a truggl may oft n be observed in animals between dif f rent instin ts, o between an nsti ct and som hab tu l di posit n as wh n d g rushes aft a h re is rebuked pauses, hesitates, pu sues again, o retu ns ashamed to his mast r

as between th lo of a f mal d g f r her ou p pp es d f her ma te —f sh may be seen to link w y to them, as f half ashamed of n t ccompan g h maste But th most curi us in tance known to m of one instin t g tti g the bett of anothe th migrat ry nstinct co qu rin the maternal instinct. Th f rm r is wond rfull stron a co fined bird will t th prope season be t h r breast against th wires f h ca until it is bare and blood It cause oung salm n to l p t of th fresh w t in which th y could co tin to xist, and thus unint ti nall to commit suicide E r n know how tro g th mat rnal instinct is, l adin r n timid bird t face great dan th h with hes t ti n, and n pposit n t th instin t of self preserv t n. N rth less, th migr tory in tinct is so powerful, that lat in th t mn swallows, h use martins, and swifts frequ ntly desert th ir t d oun , l ving th m to per ish miserabl in th ir nests.[b]

pers benef ed, or others in his stead, ma tak p b sympa hy nd good offices returned, f aid be sacrifice I t as ppears t be the case ympath tructl n t nct, ts exercise ould gi direct pleasure the same manner the exercise as bef re remarked, of almost every other instinct.

of G at Britain, 18..3, p. 5 imilar cases ha been observed in Canada b Mr. Adams P p. Science Review July 1..3, p. 283.

... nated as lions are always on the look-out for the individuals which wander from the herd

With respect to the impulse which leads certain animals to associate together and to aid one another in many ways we may infer that in most cases they are impelled by the same sense of satisfaction or pl... y ex... e ac... on as ... instinctive actions are checked We see this in innumerable instances and it is illustrated in a striking manner by the acquired instincts of our domesticated animals thus a young shepherd dog delights in driving and running round a flock of sheep but not in worrying them a young fox hound delights in hunting a fox whilst some other kinds of dogs as I have witnessed utterly disregard foxes What a strong feeling of inward satisfaction must impel a bird so full of activity to brood day after day over her eggs Migratory birds are quite miserable if stopped from migrating perhaps they enjoy starting on their long flight but it is hard to believe that the poor pinioned goose described by Audubon which started on foot at the proper time for its journey of probably more than a thousand miles co... felt

... towards special enemies No one I presume can analyse the sensations of pleasure or pain In many instances however it is probable that instincts are persistently followed from the mere force of inheritance without the stimulus of either pleasure or pain A young pointer when f... ie ... in ... it ... be ... act thus either from pleasure or pain Hence the common assumption that men must be impelled to every action by experiencing some pleasure or pain may be erroneous Although a habit may be blindly and implicitly followed independently of any pleasure or pain felt at the moment yet if it be forcibly and abruptly checked a vague sense of dissatisfaction is generally experienced

It has often been assumed that animals were in the first place rendered social and that they feel as a consequence uncomfortable when separated from each other and comfortable whilst together but it is a more probable view that these sensations were first developed in order that those animals which would profit by living in society should be induced to live together in the same manner as the sense of hunger and the pleasure of eating were no doubt first acquired in order to induce animals to eat The feeling of pleasure from society is probably an extension of the parental or filial affections since the social instinct seems to be developed by the young remaining for a long time with their parents and this extension may be attributed in part to habit but chiefly to natural selection With those animals which were benefited by living in close association, the individuals which took the greatest pleasure in society would best escape various dangers whilst those that cared least for their comrades and lived solitary would perish in greater numbers With respect to the origin of the parental and filial affections, which apparently lie at the base of the social instincts, we know not the steps by which they have been gained but we may infer that it has been to a large extent through natural selection So it has almost certainly been with the unusual and opposite feeling of hatred between the nearest relations as with the worker bees which kill their brother drones and with the queen bees which kill their daughter queens the desire to destroy their nearest relations having been in this case of service to the community Parental affection or some feeling which replaces it has been developed in certain animals extremely low in the scale for example in star fishes and spiders It is also occasionally present in a few members alone in a whole group of animals, as in the genus Forficula or earwigs

The all important emotion of sympathy is distinct from that of love A mother may passionately love her sleeping and passive infant but she can hardly at such time be said to feel sympathy for it The love of a man for his dog is distinct from sympathy and so is that of a dog for his master Adam Smith formerly argued as has Mr Bain recently that the basis of sympathy lies in our strong retentiveness of former states of pain o...

... painful even to idea We are thus impelled to relieve the sufferings of another in order that our own painful feelings may be at the same time relieved In like manner we are led to participate in the pleasures of

h l questi n of th m al sense turns. Wl sh uld man feel th t he ght t bey ne nstinct d sire r th tl an anotl r Why is l b tt ly regretf l if h has yi lded to a tro g sense of self preserv tion, and has n t risked his l fe to sa e th t f a f ll -cre ture Or hy does he regret h t l n food from l ng

It is e id t in th first place th t w th mankind th ti ti imp lse ha d ff e t d ree of tre gth a sa g w ll n k l s w lf t sa th t f a m mbe f th same communit b t will be wl lly i diff rent abo t t an u g and tim d m th r ged by tl m t rnal nst t will w tl t m ment ll sit ti n, run the gre t t d g f l e wn f t, b t t f a m re f ll w cre ture \ th l ss many m alized ma n, r n boy h n befo e risked hi l fe f an th b t f ll of co ge an l p tl y has disregarded tl e nsti t f self pres t n, and plun ed t e t at rrent t sa

wo co cerned many in tances have

one s,[38] th r tl an betra tl com au

urely the r co d ct ought to be consid red as m r l. As far as d l b rati n and the ct ry no r m t s are co cerned ar imals

f r tl good f otl rs, are not called m al M co an th g perf rmed very oft n by us, w ll t last be don w th ut d l ber ti n l sitat o an l an tl en hardly l di tin guisl ed from an in t t t urely no o e w ll p ret d tl t u l n act n ceases t be m ral O tl e contrary we all feel tl t an act

s t int

tl req t q al t e re i n t H wl o f rced to recom h f ar want f m patl bef re h cts, d serv s, h ve in e w l gh cred t tl an tl e man whose n te d posit n l ad him t a good act witl ut eff t As we ann t d t gu sl between mo t es, w ank all act ns of certain class as ral f perf rmed b m ral b g A m al be is wh e pabl f compari g l s past and f t re t ti s, and of ap pro g d sappr g of tl em We h n

m nk y face d g t rescu ts com rad tak c, arg f a orpl an m nk y w d t all ts co d t n al. B t n the ase f man wl al ca n th certai t be ra ked as m ral b g act f ce tai class are called m al, wh tl perf med d l b t ly aft truggl w tl pposing m ti s m p l ly thro gh nsti t, r from tl ffects f l ly gained h b t

B t to ret rn t u m re mmed t b ject. Altho h som t t re m re po f l than th s, d thus l ad t corre po d g act s, t t u t nable th t n man tl social nst ts (l d g th l f praise and f ar f blame) possess gre t r tre gtl

I am are tl t som p rsons mai t in th t act pe f rmed imp l l as in th bo cases, d not com und th d m m f tl e ral sense d an t be lled m ral. Th y co fi this t rm t acts d d l be t ly aft t rs pposi g d res, wh n pr pted b som lt d m t B t t p pears scarc l po sibl to d w any l ar l l d t nct of tl k d[39] A far as xalted

I refer h re t the d t cti bet ee hat has bee called *material* nd *formal* m rali ty. I am glad find that Professor H le (*Crit q nd Ad d ss* 1873, p. 287) takes th sam w thus t ject as I do. M Leslie t ph remarks (*Essay f ee Th k g nd Pla Spe k g* 1873 p. 83), "Th metaphysical distincti bet ee material nd formal morali y is as irreleva t as the uch dis ti ctions.

Ihas g re uch case m ly of thre I ta g m l d ns h preferred be g h t aft th ther t betray g th pla of th ir compa ns ar (*J rnal f Researche* 1845 p 103)

We can perceive that an instinctive impulse if it be in any way more beneficial to a species than some other or opposed instinct would be rendered the more potent of the two through natural selection for the individuals which had it most strongly developed would survive in larger numbers Whether this is the case with the migratory in comparison with the maternal instinct may be doubted The great persistence or stea ly action of the former at certain seasons of the year durin, the whole day may give it for a time paramount force

Man a social animal —Every one will admit that man is a social being We see this in his dislike of solitude and in his wish for society beyond that of his own family Solitary con finement is one of the severest punishments which can be inflicted Some authors suppose that man primevally lived in single families but at the present day though single families or only two or three together roam the soli tu les of some savage lands they always as far as I can discover hold friendly relations with other families inhabiting the same district Such families occasionally meet in council and unite for their common defence It is no argu ment against savage man being a social animal that the tribes inl abiting adjacent districts are almost always at war with each other for the social instincts never extend to all the in li viduals of the same species Judging from the analogy of the majority of the Quadrumana it is probable that the early ape like progenitors of man were likewise social but this is not of much importance for us Although man as he now exists has few pecial instincts having lost any which his early progenitors may have possessed this is no reason wl y he should not have retained from an extremely remote perio l some degree of instinctive lov and sympathy for his fello vs We are indee l all conscious that we do possess such sympathetic feelings [23] but our consciousness does not tell us whether they are instinctive having originated long ago in the same manner as with the l wer anim ils or whether they have been ac juired by each of us during our early years As man is a social ani mal it is almost certain that he would inherit a tendency to be faithful to l is comrades and obe lient to the leader of his tribe for these qualities are common to most social animals.

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desires

The social animals which stan l at the bot tom of the scale are guided almost exclusively and those which stand higher in the scale are largely guided by special instincts in the aid which they give to the members of the same community but they are likewise in part im pelled by mutual love and sympathy assisted apparently by some amount of reason Al though man as just remarked has no special instincts to tell him how to aid his fellow men he still has the impulse and with his improved intellectual faculties would naturally be much guided in this respect by reason and experi ence Instinctive sympathy would also cause him to value highly the approbation of his fel lows for as Mr Bain has clearly hewn [24] the love of praise and the strong feeling of glory

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highest degree by the wishes approbation and blame of his fellow men as expressed by their gestures and language Thus the social in stincts which must l ave been acquire l by man in a very rude state an l probably even by his early ape like pro,enitors still give the impulse to some of l m l est action but his ac tions are in a higher degree l termined by the expresse l wisl es and ju lgi ier t of l is fellow men an l unfortunately very often by his own trong elfish le ir s But a love ympatl y an l lf-comman l l com strengtl ened by habit an l as the j ow r of reasoning becomes clearer so that man can value ju tly tl e ju lg ments of his fellows l e will feel l im elf im pelled apart from any transitory pleasure or pain to certain lines of conduct He might then decl re—not tl at any ba barian or un cultivated man coul l thus tl ink—I am tl e supreme judge of my own con luct an l in tl e wor ls of Kant I ill not in my own person violate tl e lignity f humanity

The more enduring Social I tincts conquer the less persi tent Insti cts —We l ave not l ow ever as yet con i ler l tl e ma n point on whicl fr m our present j int of view tl e

[23] Hum r m rks (*An Enq y Conc gtl I r n cipl s f Mo als* ed. f 17 1 p 132) Th re

[24] *Ment l nd M al S ce* 1864 p 254

agin ti

be apt to f llow the tro g mp lse and relat tho gh this may occas nally prompt him to t deed t will m re comm l lead

-e d n g social instin t, and y m u p regard f th good p m n f h f ll ws, retr b tion ll urel com H will th n feel re m rse repe tance regret sham thi latt r feeling, h we c rel t s alm t clu ly to th j dgm t f tl rs. H will conseq ntly resol m re l ss firmly to act diff rently f r th f t re and thi consci ce f con sci ce look backwards, and serv s as a guide f th f t re

Th nat re and t gth f th feel gs which w call regret, sh m repe tance r re m rse d pe d pp re tly n t ly o th trength f th l ted nsti t, b t partl n th stre gth of th t mptat and ft n till m re th j dgm nt f f ll ws. H w far ach man al es th pprect ti n f th rs, de pend tl t gtl f hi te acq red feeling f mp th and o hi wn capac ty f reasoni g t th rem t co seq ce f his acts. A th l m t m t mpo tant, lth gh t necessary th re re ce f ar f th Gods. Sp rit beli ed by ach man and thi appli especiall ases f rem rse.

feel g f rem rse B t I can see littl f rce n tl bject M rit d n t d fi wh t th m an b rem rse and I can find n d fi nit m l g m re than an rwh lmi g sense f repe tance R m rse seems t bear th sam rel t t repe tance as ag doe t g g t pain. It is far from trang tl t an t t so tro g and so g n lly adm red as m t nal l sh ld if dis be ed l ad t th deepest misery as soon as th impress f tl past ca se f disobed nce ak ed E h an act n t p posed t no pecial insti t, m rely to kn w tl t fri nd and equals desp se us f t is no l t use gre t m sery Wh can d bt that tl ref sal t fight d l thro gh f ar has ed man m an ag y f sham Man ll ndoo t said l as bee t rred to tl bott m f l so l b h g partak n f l an foc l H re anoth case f wh t m t, I thi k, be called rem rse D Land acted as agistr t W t A tralia, and

that n w man, to sat fy his nse f duty to his wi I t ld h m that if h d d so I w uld se d h m t prison f r life He remained about th farm f r som m ths, b t g t e ceed gly thin, and complained tl at he could n t est o e t, th t his wife p rit was haunting him, because he had n t tak n a lif f r h rs I was ine o able, and assured l m th t n thing h uld save h m if h did N rth l ss the man disappeared f m re than year and th n returned n h gh co dition and his the wif told D Land th t h hu band had taken the life of a w man b l gi g t d tant tribe b t it was mposs bl t bta n l gal de ce of th Th h f rul l ld sacred by th

h as cest, n e com h rence (which th w qu t u al)

l w a rim wh ch th Au tralians h ld n th gre t t abh rence in th agree ng e actly w th certain trib f N rth Am rica. Wh n th q t n is p t n th district, t w rse to kill a g l of a f gn trib to marry girl f wn, an answ ju t ppo sit t rs w uld b n with t he t t n.[28] W m y theref e, reject th b l f l t l nsisted n by som writ rs, that th b ll rre ce f ince t d e t possess g a pec al God implanted consci ce On th wh l t t lligibl th t a man urged by so pow rf l sentim nt as rem rse th gh aris-

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Insa ity Relatio to Law O tar o, United St tes, 1871 p 1

[28] E. B Tylor in *C ntempor ry Review* April, 1873 p. 07

have through long habit acquired greater strength than the instincts of elf r

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as followed the one natural impulse rather than the other and why does he further feel that he ought to regret his con duct Man in this respect differs profoundly from the lower animals Nevertheless we can I think see with some degree of clearness the reason of this difference

Man from the acti it acul ions assing

s mind Now with those animals which live permanently in a body the social instincts are ever present and persistent Such animals are always ready to utter the danger signal to defend the community and to give aid to their fellows in accordance with their habits they feel at all times without the stimulus of any special passion or desire some degree of love and sympathy for them they are unhappy if long separated from them and always happy to be again in their company So it is with ourselves

om sympathy a fundamental element of the social instincts A man who possessed no trace of such instincts would be an unnatural monster On the

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feeling for instance of hunger nor indeed as has often been remarked of any suffering The instinct of elf

his enemy face to face The wish for another man s property is perhaps as per sistent a desire as any that can be named but even in this case the satisfaction of actual possession is generally a weaker feeling than the desire many a thief if not an habitual one after success has wondered why he stole some article [27]

A man cannot prevent past impressions often repassing through his mind he will thus be driven to make a comparison between the impressions of past hunger vengeance satisfied or danger shunned at other men s cost with the almost ever present instinct of sympathy and with his early knowledge of what others consider as praiseworthy or blameable This knowledge cannot be banished from his mind and from instinctive sympathy is esteemed of great moment He will then feel as if he had been baulked in following a present instinct or habit and this with all animals causes dissatisfaction or even misery

The above case of the swallow affords an illustration though of a reversed nature of a temporary though for the per act

At

per season these birds seem all day long to be impressed with the desire to migrate their habits change they become restless, are noisy and congregate in flocks Whilst the mother bird is feeding or brooding over her nestlings the maternal instinct is probably stronger than the migratory but the instinct which is the more persistent gains the victory and at last at a moment when her young ones are not in sight she takes flight and deserts them When arrived at the end of her long journey and the migratory instinct has ceased to act what an d t

constantly passing through her mind of her young ones perishing in the bleak north from cold and hunger

At the moment of action man will no doubt

h n r tl d b t d t b l gt tl sam f m
ly t b t n th f t g ld tl u seem t be
m t nd t ly t p rs t t e lt
t b tl com pl nt fe

t n se s, h led It s
necessary tl t tl se t ts, t g tl th sym
pathy l ul l h bee l ly cult ted t x
t nded by tl d f re so tru t l tl
l f f(od bef re y u l g ld a rul ld
e be tl ght f a d obeyed

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M t sare tte ty mu

sa a es tak h m l pl a re n ru ity to animals,[25] and h manit a unkn wn rt e Ne rth l ss, be d th family affecti ns, kindness is comm n, e pecially d n g ckn ss, bet ee th m mbers f th sam trib and

ne been highly steemed As no man can p act se th rt e ecessary fo the w lfare f his tribe witho t self sacrifice self-com mand and the pow r of endurance these qual h v be n at all time h ghly and m st j tly al ed Th Am ri an savag ol nta rily s bmt t th m th rid t rtu es w thout a groan t pro and trengthen hi f rt tude and co rag ar d w ann t l lp admi ring him r n an Indian Faki n l fro a fool sl rel gi m t ve w ngs su pended by a hook buried in hi flesh

Th oth r so-called self regarding virti es, which do n t b usly tho gh they ma really affect tl welfare f tl e tribe l ne r been e teemed by savages, tho gh n w h hly pprec ted by c vilised nat ons. The re test t temperance o repro ch w th sa g s. Utte licent sn ss, and u n t ral rimes, pre ail t an ast un l t t[28] As soo l w as m rriage, wh tl r polyg m us, m gam us, becomes comm n, j l ousy ll l ad to th incul at n f f male r t i tl s, bei g ho ured w ll t d to

t are bet ee th m mbers f th sam tribe thus Mungo Park h ard th n gro wom t aching thei y g hildren to l the truth Th s, again, is f th rt es wl ch b comes so deepl rooted in th mi d, th t t is som times p actised by sa ges, m t a l gh co t, l ard t ang b t to h to y ur my has rarely bee th ght as th hi tory f mod rn dipl mac too plainly sh ws. A soo as tribe has recognised l d dis- bed ce becomes rim an l n abject timus looked t as sa red rt As d g rud t m man an be useful faithful to h tribe w th t co rage, thu q al t has uni rsall bee placed in th high est rank and alth gl ci lised countries good t t ind man m be far m re usef l to th comm t than b e we cann t h lp in t nct ly h no n g th latter abo co ard ho be l t. Prud ce the th hand h h does t concern th w lfare of th rs, th gh ry sel l rt e has

a rem pe

ings n tl walls f P mpe and by tl p ac t ce f man sa g s.

th t f the spec s, that f an d d al m mbe f tl trib Th ce l si g ee well w th the bel f tl t tl so-called m ral sense bo gi ally d ri ed from ll social in t ts, f botl relat t first e l ly t the comm nity

Th hi f se f the l w mo al ty of sa

[25] See M B g hot, *Phy ic al Politics*, 18 2, p. 2.

[26] See, for stance M Hamilton acco t of the Kaffirs, *Anthropological Review* 18 0, p.

Mr M Le nan ha g (*P imitive M rri ge* 1865 p. 1 6) good coll cti f facts this head.

Lecky *Histo y f E pe M ls*, ol. i., 1869 p. 1 9

Embassy to Ch a, vol. ii 348.

last yield instantly and without a struggle to his social sympathies and instincts including his feeling for the judgment of his fellows The still hungry or the still revengeful man will not think of stealing food or of wreaking his vengeance It is possible or as we shall hereafter see even probable that the habit of self command may like other habits be inherited Thus at last man comes to feel through acquired and perhaps inherited habit that it is best for him to obey his more persistent impulses The imperious word *ought* seems merely to imply the consciousness of the existence of a rule of conduct however it may have originated Formerly it must have been often vehemently urged that an insulted gentleman *ought* to fight a duel We even say that a pointer *ought* to point and a retriever to retrieve game If they fail to do so they fail in their duty and act wrongly

If any desire or instinct leading to an action opposed to the good of others still appears when recalled to mind as strong as or stronger than the social instinct a man will feel no keen regret at having followed it but he will be conscious that if his conduct were known to

If he has no such sympathy and if his desires leading to bad actions are at the time strong and when recalled are not over mastered by the persistent social instincts and the judgment of others then he is essentially a bad man [?] and the sole restraining motive left is the fear of punishment and the conviction that in the long run it would be best for his own selfish interests to regard the good of others rather than his own

It is obvious that every one may with an easy conscience gratify his own desires if they do not interfere with his social instincts that is with the good of others but in order to be quite free from self reproach or at least of anxiety it is almost necessary for him to avoid the disapprobation whether reasonable or not of his fellow men Nor must he break through the fixed habits of his life especially if these are supported by reason for if he does he will assuredly feel dissatisfaction He must likewise avoid the reprobation of the one God or gods in whom according to his knowledge or superstition he may believe but in this case the additional fear of divine punishment often supervenes

The strictly Social Virtues at first alone regarded —The above view of the origin and nature of the moral sense which tells us what we ought to do and of the conscience which reproves us if we disobey it accords well with

rude men so that they may associate in a body are those which are still recognised as the most important But they are practised almost exclusively in relation to the men of the same tribe and their opposites are not regarded as crimes in relation to the men of other tribes. No tribe could hold together if murder robbery treachery &c were common consequently such crimes within the limits of the same tribe are branded with everlasting infamy [31] but excite no such sentiment beyond these limits A North American Indian is well pleased with himself and is honoured by others when he scalps a man of another tribe and a Dyak cuts off the head of an unoffending person and dries it as a trophy The murder of infants has prevailed on the largest scale throughout the world [32] and has met with no reproach but infanticide especially of females, has been thought to be good for the tribe or at least not injurious Suicide during former times was not generally considered as a crime [33] but rather from the courage displayed as an honourable act and it is still practised by some semi civilised and savage nations without reproach for it does not obviously concern others of the tribe It has been recorded that an Indian Thug conscientiously regretted that he had not robbed and strangled as many trav

have been entirely d t t t f conscience.

Lecky *H t y f E ope n Mo l* L 1869 p 223 With respect t s g s, M W n I

In d see *Th I y p f th N ra* I f r the M t a I la ds, Mull t d l y Houzeau, *Le F c lté M nt le &c* t m. n 136

tog th r with symp thy (wh ch l ad t our regarding th pprob t n and disapprobation f thers) ha ing se ed as th primary m pulse and guide Th tl e proach m ed of la ing th f und ti f th n ble t p rt of ture in th base pri ciple f selfishn ss unl ss, ndeed th satisfacti n wh ch ry animal feels, wl t f ll w ts proper insti ts, and th d ssatisfacti n felt wh n pre nted be called selfish.

Th wish s and p ni ns f the m mb rs f th sam comm nity xpressed at first o ally b t lat by writi g also th f m th sole g les f r co d t gre tly re f rce the

tru m rality has ca sed many a man m re g y than real rim W recogni the sam infl ce in th b rning sense f hame l l m t f u h f lt, aft th i t rval f y ars, b calli g t mi d som ac-

from gn ance and w ak po rs f asoni g H ce th t ang t t m and pe t t s,

h f lt by Hi doo wl breaks l ast and man th ch asc lt u ld b d f l lt t dist gu sl bet ee tl rem rse f lt b Hindoo wl h s lded t th t mpt t n of ti g un l food from th t f lt aft commi tti g th ft b t th f rm w ll prob bl be th more se re

H w so many absurd rules f co d t, as w ll as so man ab rd rel gi bel fs, h gi ted w d t kn w l w t th t tl l becom in all j art rs f th w ll leep l mpressed tl mind f m n b t t rtl y f rem k tl t bel f constantly lcated d m g tl arl y ars f lf whilst th l ain imp s bl ppears to acq re al t th t re f an t t and th ry w ce f an nst t th t t f ll ed d pend tly f aso N tl n say why ce tai admirabl t es, such as tl l f truth, are m ch m re h ghly pprec ted by

u s l ms and s perstit ns

as t be th ught nn t alth ugh they w re

plying lf sacrifice h rdl d serve to be called l w relat ch fly to self and arise from p b- m tured by xpe i ce and c lt

tl ch pe so ally unknown to him Th po l

unf rtun t l h w us h w l ng t is, before w look t th m as f ll -cre t r s. S m pathy b y nd the confine f man th t i hu

t ns. Th rs id f humanity as f r as I co ld bse was n w t m t f th G u h of tl I ampas. Th n tu f the nobl t with wl ch man i nd wed se ms to ar se in d talls from ymp th e becoming m re t d d m re w d l d ffused u t l th y are t ded to all se ti nt be gs. A soo as th rt l red and p act ed by some f w m n t p ad thro gh tru t n and x ampl l th y ung and t ally becom s corporated publ pini n

Th h l t possibl t n m al lture wh w recognise that w o ght to control

"Good nsta ces are g By M W llace in *Scient fic Opi ion*, Sept. 15 1869 d m re fully n his *C t butions to th The ry f Nat al Selection*, 18 0 p. 353.

ages as judged by our standard are firstly the confinement of sympathy to the same tribe Secondly powers of reasoning insufficient to recognise the bearing of many virtues especially of the self regarding virtues on the general welfare of the tribe Savages for instance fail to trace the multiplied evils consequent on a want of temperance chastity &c And thirdly weak power of self-command for this power has not been strengthened through long continued perhaps inherited habit instruction and religion

I have entered into the above details on the immorality of savages [38] because some authors have recently taken a high view of their moral nature or have attributed most of their crimes to mistaken benevolence [39] These authors appear to rest their conclusion on savages possessing those virtues which are serviceable or even necessary for the existence of the family and of the tribe —qualities which they undoubtedly do possess and often in a high degree

Concluding Remarks —It was assumed formerly by philosophers of the derivative school of morals that the foundation of morality lay in a form of Selfishness but more recently the Greatest happiness principle has been brought prominently forward It is however more correct to spe k of tl [illegible] ple as [illegible] con [illegible] orks [illegible] vrite

[38] See on th ubj t cop use d nce n chap vi of Sir J Lubbock *Origin of Civil t on* 1870

[39] For in tance Le ky *Hist of European Mo ls* vol i p 124

[40] This t rm i used in an able rt cle in the *Westminster Review* Oct 1869 p 498 For the Gr t t h ppiness pr nciple see J S Mill *Utilit ism* p 448

[41] Mill recogn s (*Syst m of Log* vol ii p 422) in the cl re t m n i r th [illegible] ti m y b p f m d thro gh h b t th t th t p t i f pl ur M H S k h l n h l y n l l asure d D re (*Th* [illegible]

as if there must be a distinct motive for every action and that this must be associated with some pleasure or displeasure But man seems often to act impulsively that is from instinct or long habit without any consciousness of pleasure in the same manner as does probably a bee or ant when it blindly follows its instincts Under circumstances of extreme peril as during a fire when a man endeavours to save a fellow creature without a moment s hesitation he can hardly feel pleasure and still less has he time to reflect on the dissatisfaction which he might subsequently experience if he did not make the attempt Should he afterwards reflect over his own conduct he would feel that there lies within him an impulsive power widely different from a search after pleasure or happiness and this seems to be the deeply planted social instinct

In the case of the lower animals it seems much more appropriate to speak of their social instincts as having been developed for the general good rather than for the general happiness of the species The term general good may be defined as the rearing of the greatest number of individuals in f ll [illegible]

[illegible] both of man and the lower animals have no doubt been developed by nearly the same steps it would be advisable if found practicable to use the same definition in both cases and to take as the standard of morality the general good or welfare of the community rather than the [illegible]

[illegible] en a man risks his life to save that of a fellow creature it seems also more correct to say that he acts for th [illegible]

[illegible] at an early period in the history of man the expr [illegible] f w h of the community will have naturally influenced to a large extent the conduct of each member and as all [illegible] for happiness the gre t [illegible]

[illegible] respect to th l tt r theory th tandard nd the m t f co d t ha d bt ft n bee confused but th y are really n som d gree bl nded.

[illegible] r Greatest h ppiness theory W th

r desires. Thus, as M Galton* has remarked is all th l ss rprisi as man has me ged from tat of barbari m w tl co p l recent period Alt r h g y lded to som t mptat we feel sense of dissat fac tion, l m repe tance rem rse anal go s to th feelin caused by th r po rf l m t ts des res, wh n left unsat fied or l ll compare th w ak ned impres-

w ys, t n k th r h es for th m and to take charge of th r rphans but tl ey w uld be f rced to acknowledg th t disinterested lo e f r all h gere t res, the most n ble attrib t of man was qu t be d the compreh nsio

Ne e tl l ss the diff re ce n mind between man a d th ll gh r animals, great as t s, cer tainly s o of d gree and ot f ki d We have seen that the sense a d int t s, th various em ti s and fac lt es, ch as lo e m m ry att tio no ty mitat o reason, &c. f which man boasts, may be f und an cip nt, r e n som tim s in a w ll-d l el co l t n th l animals. They are

to
ert l l m ntal pow s, l as th f rm

ff n Looki g t f t re g ti ns, th re et f ar that th soc al ti ts ll gro w k and we m y xpect th t tuo hab ts w ll grow tro g r becoming per h j fixed by nh ritance I thi case tl trug gle bet e hi h and lo e mp lse will be l ss se re, and rt e w ll be triumphant

f oth r highly ad anced ntellectual

S mm ry f the last tw Cl pler —Th re can be no d bt th t th d fference between the mind f th l west man and th t f th highest animal umm nse An anthr pom ph pe if h co ld tak d pass t w of his n case uld adm t th t th gh h could f m an artf l plan t pl d gar d —th gl h co ld se t f fighting f bre king pe ts, y t th t the th ght *of fashi ning to to a tool was quit be-* ud his scope Still less, as h w ld admit, co ld l f llow t train f m t physical reasoning sol m th matical probl m, reflect God admire grand t ral scene Som pes, l w w ld probably declare that th y co ld and did admire the be ty f th colo red ki and f f tl r partn rs in marri Th y w ld admit, that tho gl they co ld mak th pe d rstand t cri som of tl percept ns and impl ants, th ts f j ress gd fin t id as by d fi t sound had rossed th m nds. Tl might insist that they w re read t aid ther f llow-ape of tl sam troop man

grad al l ti n. Th nn bling beh f G d t n t uni ersal w th man and the b l f in piritual ag ci naturally f ll ws from other m tal po rs. Tl m ral sense perh p af f rd th be t and high t distin t n b tween man and th l w an mals b t I need say nothi g this h ad, as I ha e so lat li n de ured to sh w th t th social nst ncts — th prim pri ciple f man s m ral const t ti *—w th the aid f act e nt llect l po and th ffects f hab t, n turally l ad to the g ld n rule "As y w ld that m n sh ld d t y u d y t tl m l k w se nd thus h t th f d ti n f m rality

In th n t chapt I shall mak som few rem ks n th probabl t ps and m an by wh h th se ral m ntal and m al fac lti s f man h been grad lly l ed Th t ch l t l l ast possibl ght n t to be d nied f w daily see th se facult es d elop-ing n ry infant and w m y trace pe fect grad ti n from th mind f an utt d t, low than tl t f n animal l w in th scale the mind f a Ne ton.

* See his rema kable ork *Hereditary Gen us*, 1869, p. 349 The Duke of Argyll (*Primeval M n*, 1869 p. 188) has some good remarks the co test ma nature bet ee ght and ro g.

* Marcus Aurelius, *Meditations* Bk. V sect. 55

our thoughts and not even in inmost thought to think again the sins that made the past so pleasant to us [44] "Whatever makes any bad action familiar to the mind renders its performance by so much the easier As Marcus Aurelius long ago said Such as are thy habitual thoughts such also will be the character of thy mind for the soul is dyed by the thoughts [45]

Our great philosopher Herbert Spencer has recently explained his views on the moral sense He says I believe that the experiences of utility organised and consolidated through all past generations of the human race have been producing corresponding modifications which by continued transmission and accumulation have become in us certain faculties of moral in

There is not the least inherent improbability as it seems to me in virtuous tendencies being more or less strongly inherited for not to mention the various dispositions and habits transmitted by many of our domestic animals to their offspring I have heard of authentic cases in which a desire to steal and a tendency to lie appeared to run in families of the upper ranks and as stealing is a rare crime in the wealthy classes we can hardly account by accidental coincidence for the tendency occurring in two or three members of the same family If bad tendencies are transmitted it is probable that good ones are likewise transmitted That the state of the body by affecting the brain has great influence on the moral tendencies is known to most of those who have suffered from *chronic derangements of the digestion or liver* The same fact is likewise shewn by the perversion or destruction of the moral sense being often one of the earliest symptoms of mental derangement and insanity is notoriously often inherited Except through the principle of the transmission of moral tendencies we cannot understand the differences believed to exist in this respect between the various races of mankind

Even the partial transmission of virtuous tendencies would be an immense assistance to the primary impulse derived directly and indirectly from the social instincts Admitting for a moment that virtuous tendencies are inherited it appears probable, at least in such cases as chastity temperance humanity to animals, &c that they become first impressed on the mental organization through habit instruction

possessing such virtues having succeeded best in the struggle for life My chief source of doubt with respect to any such inheritance is that senseless customs superstitions and tastes such as the horror of a Hindoo for unclean food ought on the same principle to be transmitted I have not met with any evidence in support of the transmission of superstitious customs or senseless habits although in itself it is perhaps not less probable than that animals should acquire inherited tastes for certain kinds of food or fear of certain foes

Finally the social instincts which no doubt were acquired by man as by the lower animals for the good of the community will from the first have given to him some wish to aid his

more remote consequences of his actions as he acquired sufficient knowledge to reject baneful customs and superstitions as he regarded more and more not only the welfare but the happiness of his fellow men as from habit following on beneficial experience instruction and ex*ample his sympathies became more tender and* widely diffused extending to men of all races to the imbecile maimed and other useless members of society and finally to the lower animals, —so would the standard of his morality rise higher and higher And it is admitted by moralists of the derivative school and by some intuitionists that the standard of morality has risen since an early period in the history of man [48]

As a struggle may sometimes be seen going on between the various instincts of the lower animals it is not surprising that there should be a struggle in man between his social instincts with their derived virtues, and his lower though momentarily stronger impulses

[44] Tennyson *Idylls of the King* p 244

[45] Marcus Aurelius *Meditations* Bk V sect 16

[46] Letter to Mr Mill in Bain's *Mental and Moral Science* 1868 p 722

[47] Maudsley *Body and Mind* 1870 p 60

in man, but in their probability no knowledge permits the attempt.

It deserves notice that, as soon as the progenitors of man became social (and this probably occurred at a very early period) the principle of imitation, and reason, and experience would have increased and much modified the intellectual powers in a way, of which we see only traces in the lower animals. Apes are much given to imitation, as are the lowest savages; and the simple fact previously referred to, that after a time no animal can be caught in the same place by the same sort of trap, shews that animals learn by experience, and imitate the caution of others. Now, if some one [illegible]

[illegible] like use in some slight degree strengthen the intellect. If the new [illegible] were an important one, the tribe would increase in number, spread and supplant other tribes. In a tribe thus rendered more numerous there would always be a rather greater chance of the birth of other superior and inventive members. If such men left children to inherit their mental superiority, the chance of the birth of still more ingenious members would be somewhat better, and in a very small tribe decidedly better. Even if they left no children, the tribe would still include their blood-relations; and it has been ascertained by agriculturists[1] that by preserving and breeding from the family of an animal, which when slaughtered was found to be valuable, the desired character has been obtained.

Turning now to the social and moral faculties [illegible]

feelings which impel the animals to [illegible] and they no doubt exhibited the same general disposition. They would have felt uneasy when separated from their comrades, for whom they would have felt some degree of love; they would have warned each other of danger, and have given mutual aid in attack or defence. All this implies some degree of sympathy, fidelity, and courage. Such social qualities, the paramount importance of which to the lower animals is disputed by no one, were no doubt acquired by the progenitors of man in a similar manner, namely, through natural selection, aided by inherited habit. When two tribes of primeval man, living in the same country, came into competition, if (other circumstances being equal) the one tribe included a great number of courageous, sympathetic and faithful members, who were always ready to warn each [illegible]

[illegible] all important in the never-ceasing wars of savages, fidelity and courage must be. The advantage which disciplined soldiers have over undisciplined hordes follows chiefly from the confidence which each man feels in his comrades. Obedience, as Mr. Bagehot has well shewn, is of the highest value, for any form of government [illegible]

[illegible] tors us [illegible] other tribes; but in the course of time it would, judging from all past history, be in its turn overcome by some other tribe still more highly endowed. Thus the social and moral qualities would tend slowly to advance and be diffused throughout the world.

But it may be asked, how within the limits of the same tribe did a large number of members first become endowed with these social and moral qualities, and how was the standard of excellence raised? It is extremely doubtful whether the offspring of the more sympathetic and benevolent parents, or of those who were the most faithful to their comrades, would be reared in greater numbers than the children of selfish and treacherous parents belonging to the same tribe. He who was ready to sacrifice his life, as many a savage has been, rather than betray his comrades, would often leave no offspring to inherit his noble nature. The bravest men, who were always willing to come to the front in war, and who freely risked their lives for others, would on an average perish in larger numbers than other men. Therefore it hardly seems probable that the number of men gifted with such virtues, or that the standard of their excellence, could be increased through natural selection, that is, by the

[1] I have given instances in my 'Variation of Animals under Domestication,' vol. ii. p. 196.

[2] See a remarkable series of articles on 'Physics and Politics,' in the 'Fortnightly Review,' Nov. 1867; April 1, 1868; July 1, 1869, since separately published.

CHAPTER V

ON THE DEVELOPMENT OF THE INTELLECTUAL AND MORAL FACULTIES DURING PRIMEVAL AND CIVILISED TIMES

The subjects to be discussed in this chapter are of the highest interest but are treated by me in an imperfect and fragmentary manner Mr Wallace in an admirable paper before referred to[1] argues that man after he had partially acquired those [illegible] al [illegible] means For man is enabled through his mental faculties to keep with an unchan[illegible] [illegible] and various stratagems to procure food and to defend himself When he migrates into a colder climate he uses clothes builds sheds and m[illegible] [illegible] n at a remote period he practised some division of labour

The lower animals on the other hand must have their bodily structure modified in order to survive under greatly changed conditions They must be rendered stronger or acquire more effective teeth or claws for defence against new enemies or they must be reduced in size so as to escape detection and danger When they migrate into a colder climate they must become clothed with thicker fur or have their constitutions altered If they fail to be thus modified they will cease to exist

The case however is widely different as Mr Wallace has with justice insisted in relation to the intellectual and moral faculties of man These faculties are variable and we have every reason to believe that the variations tend to be inherited Therefore if they were formerly of high importance to primeval man and to his ape like progenitors they would have been perfected or advanced through natural selection Of the high importance of the intellectual faculties there can be no doubt for man mainly owes to them his predominant position in the world We can see that in the rudest state of society the individuals who were the most sagacious who invented and used the best weapons or traps and who were best able to defend the[illegible] [illegible] ould increase in number and supplant other tribes Numbers depend primarily on the means of subsistence and this depends partly on the physical nature of the country but in a much higher degree on the arts which are there practised As a tribe increases and is victorious it is often still further increased by the absorption of other tribes[2] The stature and strength of the men of a [illegible] can be obtained In Europe the men of the Bronze period were supplanted by a race more powerful and judging from their sword handles with larger hands[3] but their success was probably still more due to their superiority in the arts

All that we know about savages or may infer from their traditions and from old monuments the history of which is quite forgotten by the present inhabitants shew that from the remotest times succe[illegible] [illegible] in regions of the earth on the wild plains of America and on the isolated islands in the Pacific Ocean At the present day civilised nations are everywhere supplanting barbarous nations excepting where the climate opposes a deadly barrier [illegible] perfected through natural selection and this conclusion is sufficient for our purpose Undoubtedly it would be interesting to trace the development of each separate faculty from the state in which it exists in the lower animals to that in which it exist[illegible]

[1] *Anthropological Review* May 1864 p clxx

[2] After a time the members of tribes which are absorbed [illegible] (*Anthrop Rev* 1864 p 131) [illegible] descendants of the same [illegible]

[3] [illegible] *Nat* 1860 p 294

do ed in ...

and increase.

It s, h w y difficult to f rm any j dgm t why o e p rt cul tribe and not anoth has been successf l and has r sen in tl e scal f ci l ti n Many sa ges ar in tl sam cond ti n as wh n fi t d sco e ed lce t ri s A M B g h t l as re- r k l w re nt t look t tl progr ss as

H nry Mai e an gre l as n h parts fe of desire tl t its ci l nstit t s l ld b mpro ed Pro ess se ms to d pe d many co t fa rabl co d t ns far too compl x to b fol l ed t. B t t has ft be m ked th t a cool l m t f m l ading t i dustry and t tl ar s rt l as b h ghly f abl tl ret Et E m pressed by h rd ecessity h ceeded many g m us t ns, b t tl cl m t has been too se- re f co t ed prog N mad h b ts, l th w d plains, tl ro h th d ns f ests f tl trop cs l g tl h re f the sea, h e case bee l ghly d trime tal Wl lst bserv the barb ro nh b ta ts f T d l F g t truck th t th

of tl gro d and th first t p e lts ti ld probabl lt, as I h lse li re t from som h ace d t as th seed f fru t tree f ll h g f refuse and produc an ally fi an ty Th prob- l m, l f tl first ad ance f sa ges l l ci l sat t prese t m l too d ff lt to be sol ed

*Nat al s lectio as ff ct g C vilised Na- t —*I l th rto nly co d ed th ad e t f m from human co d t t th t f tl mod rn sa ag B t som m k tl act f nat al selecti n l sed nat ns may be w rtl add g Th l j ct has bee ably d scussed by M W R.

Gr nd p ou ly by M W ll ce and Mr Galt n Mo t f my r marks are taken from th e tl ree th rs W th sa ag s, the w ak in body r mind are soon el min ted and those th t r s e commo ly e h b t a gorou s h lt W ci l ed me on the other l

t sa

m m nt Tl s r ason to bel e th t acci l p rved tl nds, wl o f om

m

highly ijuri u t tl e ace of m n. It s p g h w soon a want f care r re w ly d ected l ads t the d r ti n of

h lpl ss mai ly an cid ntal re ult f tl e st ct f symp thy wh ch was ori nally a quired as part f th soc al ti ts but s b e q tly rend ed in the mann r p usly d cated m r ten f and mo wid ly d f fused N co ld we check ur ymp tl y e n at th u gin f l ard ason, w tl t d teri a- t tl bl t part f tu e Tl e su geon m y h rd n h mself wl l t perform g an

u g and p pag t g th k nd but th e pp rs to be t l ast check n t dy act namely th t the weak and nf r

Ancient Law 1861 p. 22. F M B g hot remarks, Fort ghtly Review April 1 1868, p 4 2.

The V riation of A imal nd Pl nts nder Do- m stication, ol i., p 309

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survival of the fittest, for we are not here speaking of one tribe being victorious over another.

Although the circumstances leading to an increase in the number of those thus endowed within the same tribe are too complex to be clearly followed out, we can trace some of the probable steps. In the first place, as the reasoning powers and foresight of the members became improved, each man would soon learn that if he aided his fellow men, he would commonly receive aid in return. From this low

of sympathy which gives the first impulse to benevolent actions. Habits, moreover, followed during many generations probably tend to be inherited.

But another and much more powerful stimulus to the development of the social virtues is afforded by the praise and the blame of our fellow men. To the instinct of sympathy, as we have already seen, it is primarily due that we habitually bestow both praise and blame on others, whilst we love the former and dread the latter when applied to ourselves; and this instinct no doubt was originally acquired, like all the other social instincts, through natural selection. At how early a period the progenitors of man in the course of their development became capable of feeling and being impelled by the praise or blame of their fellow creatures, we cannot of course say. But it appears that even dogs appreciate encouragement, praise and blame. The rudest savages feel the sentiment of glory, as they clearly show by preserving the trophies of their prowess, by their habit of excessive boasting, and even by the extreme care which they take of their personal appearance and decorations; for unless they regarded the opinion of their comrades, such habits would be senseless.

They certainly feel shame at the breach of some of their lesser rules, and apparently remorse, as shewn by the case of the Australian who grew thin and could not rest from having delayed to murder some other woman, so as to propitiate his dead wife's spirit. Though I have not met with any other recorded case, it is scarcely credible that a savage who will sacrifice his life rather than betray his tribe, or one who will deliver himself up as a prisoner rather than break his parole[6] would not feel remorse in his inmost soul, if he had failed in a duty which he held sacred.

We may therefore conclude that primeval man, at a very remote period, was influenced by the praise and blame of his fellows. It is obvious that the members of the same tribe would approve of conduct which appeared to them to be for the general good, and would reprobate that which appeared evil. To do good unto others—to do unto others as ye would they should do unto you—is the foundation-stone of morality. It is, therefore, hardly possible to exaggerate the importance during rude times of the love of praise and the dread of blame. A man who was not impelled by any deep instinctive feeling, to sacrifice his life for the good of others, yet was roused to such actions by a sense of glory, would by his example excite the same wish for glory in other men, and would strengthen by exercise the noble feeling of admiration. He might thus do far more good to his tribe than by begetting offspring with a tendency to inherit his own high character.

With increased experience and reason, man perceives the more remote consequences of his actions, and the self-regarding virtues, such as temperance, chastity, &c., which during early times are, as we have before seen, utterly disregarded, come to be highly esteemed or even held sacred. I need not, however, repeat what I have said on this head in the fourth chapter. Ultimately our moral sense or conscience becomes a highly complex sentiment—originating in the social instincts, largely guided by the approbation of our fellow men, ruled by reason, self-interest, and in later times by deep religious feelings, and confirmed by instruction and habit.

yet that an increase in the number of well-endowed men and an advancement in the standard of morality will certainly give an immense advantage to one tribe over another. A tribe including many members who, from possessing in a high degree the spirit of patriotism, fidelity, obedience, courage, and sympathy, were always ready to aid one another, and to sacrifice themselves for the common good, would be victorious over most other tribes; and this would be natural selection. At all times throughout the world tribes have supplanted other tribes; and as morality is one

[6] Mr. Wallace gives cases in his *Contributions to the Theory of Natural Selection*, 1870, p. 354.

and increase.

It is, h w r ry difficult to f rm any j d m t why o e p ticular tr be and n t anoth has been successf l and has rise n tl scal of ci ilisati n Many sav ges are tl sam co d t as wh first d sco red se l ce t ries ts M Bag h t has re- m ked w pt t look at the progr ss as

H nry Mai e b
has sh w a part l f des re th t ts ci l nstit t ns l ld be mpro ed l ro ress seems to d pe d many con rent fa- rabl cond t s, far too comple to be f l l ed o t. B t t has ft n been remarked that cool l m t from lead g to dustry nd t tl n t l as b en l ghly f abl tl ret Tl e Esq m ux pressed by hard ecessit h ceeded many ing ni t ns, b t tl climate l as been too se- re f co t ed progr ss N mad hab ts, l th w d plains, thro gh th d ns f re ts f th trop cs, al g th h re f th sea, l case bee h gl ly d trim n tal. Wl lst bserv g th barb ro nhab tants f T rr d l F g t truck m th t tl

ld probabl re ult, as I h lsewh re l from som ch accid t as th seeds of fru t tree f ll ng h f f se, and produci an all fi an ty Th prob- lem l f tl first ad ance f sa ges t and ci l sati t present m h too d ff cult to be sol ed

Nat al S lect as ff ct g C vilised Na- t ns.—I t th rt nly cons d red th ad t f m from sem h man condi t th t f th mod rn sa ag B t som remark th act f t ral selecti ci l sed nat ns m y be w rth add g Th l t has bee ably d scussed by M W R.

Gre a d pre sly by M Wallace and Mr G lto M t of my remarks are taken from th se three a th rs. With sa s, the w ak n body mind are soon limin ted and those th t comm nly xh b t a rous f h lth We ci l ed m n, on the oth r l

l w and ur med cal m n ex rt tl m t skill t sa e tl lif of e ery on to tl e la t mon t Tl re reason to b l ve th t vacci n ti n has pr served tl sands, wl o from w k co t tuti n w ld fo m rly ha s c

p i g h w soon a want of care or are w ly l ected leads t the d g tion of

qured as part f th soc l inst ts, b t bse- que tly re dered m th mann r pre n u ly indi cated m t nd r and m re w d ly dif f sed N r co ld w check mp thy t th u g g f th rd r ason, w th ut d teri a ti n th bl t part f o ture The s geo m h rd n himself wh lst perf rmi g an pe t n, f he kn w th t l e is act fo th good f h p t nt but f e w te ti nally t glect the w ak and h lpless t co ll ly b f a co ti g nt b n fit with an o rwh lmi g p sent l W m t th ref b ar th und btedly bad ffects of th w ak rv ving and p p g t g th kind b t ll re ppears to b t l ast o e check in t ady act nam ly that the weak and nf ri r

Ancient La 1861 p. 22. For Mr Bag hot remarks, *Fort ghtly Review* April 1 1868, p. 4 2.

The V riation of A imals nd Pl nts nder Do- m stication, ol. i., p. 309

F aser M g zine Sept 1868, p 353 This art l seems t h truck m y perso s, d ha rise t t remark bl ssa d j d

M E. Ray La kest his *Compa t Lo gevity* 1870 p 128. Sim la ew ppe red pre usly th *Austr lian* July 13 1867 I ha borro ed idea from sev l of these t rs.

F M W llace see *Anth pological Review* as bef re ted. Mr Galt *Macm la M g ne* A g 1865 p 318 also his great w k, *Hereditary Genius* 1870.

members of society do not marry so freely as the sound and this check might be indefinitely increased by the weak in body or mind refraining from marriage though this is more to be hoped for than expected

In every country in which a large standing army is kept up the finest young men are taken by the conscription or are enlisted They are thus exposed to early death during war are often tempted into vice and are prevented from marrying during the prime of life On the other hand the shorter and feebler men with poor constitutions are left at home and consequently have a much better chance of marrying and propagating their kind [1]

Man accumulates property and bequeaths it to his children so that the children of the rich have an advantage over the poor in the race for success independently of bodily or mental superiority On the other hand the children of parents who are short lived and are therefore on an average deficient in health and vigour come into their property sooner than other children and will be likely to marry earlier and leave a larger number of offspring to inherit their inferior constitutions But the inheritance of property by itself is very far from an evil for without the accumulation of capital the arts could not progress and it is chiefly through their power that the civilised races have extended ² where ace of ... rate accu ... ation of wealth interfere with the process of selection When a poor man becomes moderately rich his children enter trades or professions in which there is struggle enough so that the able in body and mind succeed best The presence of a body of well instructed men who have not to labour for their daily bread is important to a degree which cannot be over estimated as all high intellectual work is carried on by them and on such work material progress of all kinds mainly depend not to mention other and high ... oubt ... men ... ever ... a some degree of elimination here occurs for we daily see rich men who happen to be fools or profligate squandering away their wealth

Primogeniture with entailed estates is a more direct evil though it may formerly have been a great advantage by the creation of a dominant class and any government is better than none Most eldest sons, though they may be weak in body or mind marry whilst the younger son however superior in these respects do not so generally marry Nor can worthless eldest sons with entailed estates squander their wealth But here, as elsewhere the relations of civilised life are so complex that some compe ... rene ... atur ... a ... rat n ... t ... ore beautiful and charming women and these must generally be healthy in body and active in mind The evil consequences, such as they may be of the conti ... f ... r wealth and power and thus th s effect by marrying heiresses But the daughters of parents who have produced single children are themselves as Mr Galton[3] has shewn apt to be sterile and thus noble families are continually cut off in the direct line and their wealth flows into some side channel but unfortunately this channel is not determined by superiority of any kind

Although civilisation thus checks in many ways the action of natural selection it apparently favours the better development of the body by means of good food and the freedom from ... be in ... ound ... ro ger ... savages They appear also to have equal powers of endurance as has been proved in many adventurous expeditions Even the great luxury of the rich can be but little detrimental for the expectation of life of our aristocracy at all ages and of both sexes, is very little inferior to that of healthy English lives in the lower classes

We will now look to the intellectual faculties If in each grade of society the members were divided into two equal bodies, the one including the intellectually superior and the other the inferior there can be little doubt that the former would succeed best in all occupations, and rear a greater number of children Even in the lowest walks of life skill and ab...

¹ Prof H F k (*Ei ft s der Natur wissenschaft f das Recht* Jun 18 2) has some good remarks on this head and on other such points.

[2] *Her d t y G* ... 18 0 pp 132 140
[3] *Q atref g s, P* ... *d* ... *Scient fiq s* 1867 68 p 659
... see th fifth and sixth columns compiled from good authorities, in the table given in Mr F. H. Ladiest ... *C mparat Lo gevity* 18 0 p. 115

ty mu.t be of some ad anta th gh n many occupati ns, wing t th great d n of labo very small H ce n alised nati ns there w ll be som t nd to an in crease both in th numbe and in the ta dard of th int llect ally abl B t I do n t wish to assert th t thi t nd cy m y n t b more than counterbalanced n th w ys, as by the mult plicati f th reckl ss and impro d t b t n to ch as th se bil ty must be so

f

ha u ua

their gre t int llect. Mr Galto says, I regret I am unable to sol the simple q ti n h th and h w far m n and w m n who are prod nes f geni s are inf rt le I h h w sh wn that m n f min ce are by n m ans so.[16] Great la gi rs, th f nd rs f be fice t relig ns, gre t philosoph rs and disco rers n sci ce, aid the pro ress f man kind far l gh d gree by th ir w ks than by l ing um ro s prog y In th

di iduals, and t th prese ti n of tro gly m ked and rare an m l s, th t l ad t th ad ancem nt f a pec s. So t will be with th t llectual facult s, since th som wh t abl m ach g d f soci ty ceed th bett than th l ss ble, and conse q tl increase mbe f t th ra se pre ted Wh an nat tl t dard f tellect and th umbe f t llect al m h ncreased w may xpect from th l w f tl d t from an age, that prod g of g nius w ll as sh wn by Mr G lton, ppear som h t m re freq tly than bef re

I re ard to th m ral q aliti s, som limi nat f tl rst d sposit ns alw y pr res tl most civilised t ns. Mal fact rs are e ted impriso ed f lo g periods, so that th t freely t ansm t tl bad q al t es. Melan l l and in sa pers a confi ed commit uicid V l t al q rrelsom m oft com t bk l ol Th re tless l w ll t f llow an t al occupat —and tl rel f bar ban m is gre t l ck to ca l sati —emi g t to ne ly-settled co tries, wh re th y pro useful p ee s. Int mper nce s so l gh ly d tru ti e, th t the xpectat n of lif of the t mpe te t the ge of th rty fo i tance o ly 13 8 a s whilst f the u al labo re of England t th same g it i 40 9 y rs.[19] Proflig te w men bear f w childr n, and profl g t men rarely ma r l oth ff r from disease In th breed g f d m tic ani mals, th l mm t n f those d d als, th gh f w n number wh ch are m any m ked manne inf ri s b no m ns an unimport t l m t t w rds uccess. Thi especially h lds good w th jurious charact s whi h t d to re ppear thro gl re rs n, h as blackn ss n sheep and with manki d m f th w r t d po t ns, which occa-

w seems deed ecognised in th comm n express n th t ch men re th bl k sheep of th famil

W th c lised t s, as far as an ad anced standard f m rality and an in r ased number f fai ly good m n ar co cerned natural select n pparently ffects b t little th gh th f d m ntal social nsti cts w re riginally th s gained B t I ha alre d sa d gh,

— xampl and m t t n—reaso — xperi ce and self int re t—instru t n duri g th, and rel g feelings.

A most mportant b tacl m alised coun tri to an in rease in th umb f m n f a peri class has bee tr gly ns ted n by Mr Greg and Mr G lt nam ly th fa t that th y poo and reckl ss, who are ften d graded by ce almo t in ari bly m rry arl whilst th areful and f gal who are g rall therwise rt us, marry lat n so th t th y m y b abl to pport th m sel and th ir hildren n comf rt Th se wh marry arly prod ce w thin gi period n t al gre t numbe f g rati ns, b t,

Hereditary Gen us, 18 0 p. 330.
Orig of pec thi ed ti n, p. 42.
Hereditary Gen us, 1 0 p. 347

E. Ray La kest Compa at Lo gevity 1870, p 115 Th tabl of th int mperat is from N iso I ital Statistic I regard to profl g cy see D F rr Influence of Marriag M rtality Nat Assoc for th Promotio of Social Science 1858

F aser M gazine Sept., 1868, p 353 Macmillan M ga.ine A g 1865 p. 318. Th Rev F W F rra F aser M gazine A g 18 0, p. 264) takes differe t iew

as shewn by Dr Duncan [20] they produce many more children The children moreover that are borne by mothers during the prime of life are heavier and larger and therefore probably more vigorous than those born at other periods Thus the reckless degraded and often vicious members of society tend to increase at a quicker rate than the provident and generally virtuous members Or as Mr Greg puts the case The careless squalid unaspiring Irishman multiplies like rabbits the frugal foreseeing self respecting ambitious Scot stern in his morality spiritual in his faith sagacious and disciplined in his intelligence passes his best years in struggle and in celibacy marries late and leaves few behind him Given a land originally peopled by a thousand Saxons and a thousand Celts—and in a dozen generations five sixths of the population would be Celts but five sixths of the property of the power of the intellect would belong to the one sixth of Saxons that remained In the eternal struggle for existence it would be the inferior and *less* favoured race that had prevailed—and prevailed by virtue not of its good qualities but of its faults

There are however some checks to this downward tendency We have seen that the intemperate suffer from a high rate of mortality and the extremely profligate leave few offspring The poorest classes crowd into towns and it has been proved by Dr Stark from the statistics of ten years in Scotland [1] that at all ages the death rate is higher in towns than in rural districts and during the first five years of life the town death rate is almost exactly double that of the rural districts As these returns include both the rich and the poor no doubt more than twice the number of births would be requisite to keep up the number of the very poor inhabitants in the towns relatively to those in the country With women marriage at too early an age is highly injurious for it has been found in France that Twice as many wives under twenty die in the year as died out of the same number of the unmarried The mortality also of husbands under twenty is excessively high [22] but what the cause of this may be seems doubtful Lastly if the men who prudently delay marrying until they can bring up their families in comfort were to select, as they often do, women in the prime of life the rate of increase in the better class would be only slightly lessened

It was established from [illegible] ... anger [illegible] ion than the married for instance out of every 1000 unmarried men between the ages of twenty and thirty 11 [illegible]

[illegible] in 1864 with the entire population above the age of twenty in Scotland for instance out of every 1000 unmarried men between the ages of twenty and thirty 14 0 annually died whilst of the married only [illegible]4 died that is less than half [1] Dr Stark remarks on this Bachelorhood is more destructive to life than the most unwholesome trades or than residence in an unwholesome house or district where there has never been the most distant attempt at sanitary improvement He considers that the lessened mortality is the direct result of marriage and the more regular domestic habits which attend that state He admits however that the intemperate profligate and criminal classes whose duration of life is low do not commonly marry and it must likewise be admitted that men with a weak constitution ill health or any great infirmity in body or mind will often not wish to marry or will be rejected Dr Stark seems to have come to the conclusion that marriage in itself is a main cause of prolonged life from finding that aged married men still have a considerable advantage in this respect over the unmarried of the same advanced age but every one must have known instances of men who with weak health during youth did not marry and yet have survived to old age though remaining weak and therefore always

[20] On the Laws of the Fertility of Women [illegible] *Transactions of the Royal Society* Edinburgh [illegible] p 287 [illegible] published [illegible] the title of *Fecundity Fertility and Sterility* 1871 See also Mr Galton *Hereditary Genius* pp 352-357 for observations to the above effect.

[illegible] *Tenth Annual Report of Births Deaths &c in Scotland* 1867 p xxix

[22] These quotations are taken from [illegible]

[illegible] quoted [illegible] Dr [illegible] paper On the [illegible] of Marriage [illegible] tality of the [illegible] People [illegible] before the [illegible] Social Science [illegible] 1858.

[23] Dr [illegible] ibid The quotations [illegible] below are [illegible] ted from the same striking paper

[24] I [illegible] them [illegible] Tenth [illegible] al Report of Births Deaths [illegible] Scotland 1867 The quotation [illegible] from Dr Stark [illegible] extracted from [illegible] Daily News Oct 17 1868 [illegible] Dr Farr considers [illegible] refully written

with a l sse ed chance f lif r of marryi g There is an th remarkabl cum tance hich seems to suppo t D Stark s conclus n nam ly that d ws and w d wers n Fran suff r in comparison with tl e m rried ry h ry rate f m rtal ty b t D Far t trib te this to th po rty a d l hab ts conseq t n the di rupti n f th family and t gri f O the wh l we m y concl de th Dr Farr th t tl e lesse m rtal ty f m rried than f unmarried m n, which seems t be g e al l mainly d e to th con tant l minat n f mperfect t pes, and to the skilful selecti n of th fin t nd d als t f ach ccessi g e ti n the selec t relati lv t th ma riage tat and acting all corporeal t llect al, and m al q al t s.[28] W ma th ref re infe that so d and good m n wh t f pru d nce remain f a tim unmarried do n t suff h gh rat f m rtal ty

If the ari us checks pecified in the tw l t paragraphs, and pe h p tl rs as y t un

class of m n, th natio will retrograd as has too ft occurred in th h t ry f th wo ld. W must remembe that progress n an abl rul It is ry d fficult to say why ci l sed nati n rises, becom mo pow rful, and spread m re w d ly than an th t th sam ti gresse m re quickly t tim than t an tl W an ly say tl t t d pends an increase in the actual mbe f th pop l ti n, th mbe f m nd wed wit high t llect al and m ral fac lties, as well as th tand rd f cel lence C rporeal tru t re ppear to h e littl fl ce cept so f as g ur of body l ad to ou f m d

It has bee g d b se al writ rs th t as high t llect l pow are ad a tage t t n, th ld Greeks, h tood som grad s h ghe t l ect than any race th t has xi ted [29] ght, f th po f nat al selec t re real, t h rise still high the sc l ncreased mbe and stocked th l of E rope H w ha th tacit as-

sumption, so oft n made with re pect to cor poreal tru tures th t there i some i n te tend cy t wards continued de elopment in mind and body B t de elopme t of all kinds d pend on many co c rrent fa ou able cir cum tances. Natu al select on act only t nta ti ely I di duals and aces may ha e ac quired ce tain i di p tabl ad ant g s, and yet ha e perished f om fail g n ther char act s. The Greeks may have retrog aded from want of cohe n ce between the many small tat s, from the small size f th r wh le co ntry from th p a tice f la e y from extrem sensuality fo th y d d n t uccumb u t l th y were n r ted and corrupt to th v ry core [30] The western nati ns of E rope wh w mmea ably surpass the former

w ks f th t w nd rful people

Wh can positi ly say why the Spani h na ti n, so d min t t e time, has be n dis tanced in the race Th aw keni g f the na tions f Europe from the dark ages s a till m re pe l ming problem At th t arly period as Mr Galt n has remarked alm t all the m n of ge tl n t re th se giv n to med ta ti n cult re f th mind had no ref ge e cept in the bosom f a Cl urch which de manded celibacy [31] and th could hardl fail to h had a d t n rating nfl nce n ach success g n rati n Dur thi same period th H l I q i t n selected with e treme are th free t and bold t m n in ord to b rn r imprison them In Spain alo som of th b st m n—tl se wh d ubted and q es ed and with ut d bting there can be no progress—w re limi ted d ring three cen t es at th t f a th sand year Th e l wl ch the C th l Church has thus flected is incal labl th gh no d bt coun t balanced t a certain, perhaps to large t t the w s n erth less, Europe l as progressed n paralleled

Th remarkabl s ccess f the En lish as col n ts, compared to th European na

[28] D D nca remarks (*F cundity Fertility &c.*, 1 71 p 334) th subject At ev ry g the heal hy nd bea tiful go er from th nmarried side t the married, leavi g the married columns ded th the sickly nd nfortunat

[29] See the genious and original argume t this b ect by M Galton, *Her ditary Genius*, pp. 340-342.

tions has been ascribed to their daring and persistent energy a result which is well illustrated by comparing the progress of the Canadians of English and French extraction but who can say how the English gained their energy There is apparently much truth in the belief that the wonderful progress of the United States as well as the character of the people are the results of natural selection for the more energetic restless and courageous men from all parts of Europe have emigrated during the last ten or twelve generations to that great country and have there succeeded best [29] Looking to the distant future I do not think that the Rev Mr Zincke takes an exaggerated view when he says [30] All other series of events—as that which resulted in the culture of mind in Greece and that which resulted in the empire of Rome—only appear to have purpose and value when viewed in connection with or rather as subsidiary to the great stream of Anglo-Saxon emigration to the west Obscure as is the problem of the advance of civilisation we can at least see that a nation which produced during a lengthened period the greatest number of highly intellectual energetic brave patriotic and benevolent men would generally ... vail over less

... the struggle ... pid rate of increase It is impossible not to regret bitterly but whether wisely is another question the rate at which man tends to increase for this leads in barbarous tribes to infanticide and many other evils and in civilised nations to abject poverty celibacy and to the late marriages of the prudent But as man suffers from the same physical evils as the lower animals he has no right to expect an immunity from the evils consequent on the struggle for existence Had he not been subjected during primeval times to natural selection assuredly he would never have attained to his present rank Since we see in many parts of the world enormous areas of the most fertil ...

... at the struggle for existence had not been sufficiently ... to force man upwards to his highest standard Judging from all that we know of man and the lower animals there has always been sufficient variability in their intellectual and moral faculties for a steady advance through natural selection No doubt such advance demands many favourable concurrent circumstances but it may well be doubted whether the most favourable would have sufficed had not the rate of increase been rapid and the ...

... that a people which may be called civilised such as the Spanish settlers, ... liable to become indolent and to retrograde when the conditions of life are very easy With highly civilised nations continued progress depends in a subordinate degree on natural selection for such nations do not supplant and exterminate one another as do savage tribes Nevertheless the more intelligent members within the same community will succeed better in the long run than the inferior and leave a more numerous progeny and this is a form of natural selection The more efficient causes of ...

... e t and best men embodied in the laws customs and traditions of the nation and enforced by public opinion It should however be borne in mind ...

... as this appreciation is founded on our sympathy which it can hardly be doubted was originally developed through natural selection as one of the most important elements of the social instincts [3]

On the evidence that all civilised nations were once barbarous —The present subject has been treated in so full and admirable a manner by Sir J Lubbock [32] M ... Tylor Mr M Lennan and others that I need here give only the briefest summary of their results The arguments recently advanced by the Duke of Argyll [33] and formerly by Archbishop Whately in favour of the belief that man came into the world as a civilised being and that all savages have since undergone degradation seem to me weak in comparison with those advanced on ...

[29] Mr Galton Macmillan's Mag ... 186 ... See also Nat ... O D ... Nation Dec. 1869 p 184
Last Winter in the United States 1868 p 29

... doubted ... M ... J ... the subject see L Broca ... Les Sélections ... 1872
... O ... Origin of Civilisation ... *the Fit* ... Society Nov 26 1867
[33] *Primeval Man* 1869

latt h ad I ha m t with n evid nce. F gians w re probably compelled by th co q eron h rd to settl th inh p ta ble country and th m y h e becom in conseq ence som wh t m re d graded b t it ld be difficult t pro th t th y ha fale much bel w th Botocudos, who inhab t th fin st parts f Braz l.

Th id nce th t all ci ilised n ti ns are th descendants f barbarians, consists, n th one ide, of cl ar trace f th ir f rm l w cond ti still-exist g customs, beliefs, language, &c. and th th sid f proof that sa ges are i d pe dentl abl t raise th msel f w t p th scal f ci ilisa tion, and ha act all thus risen. Th e d nce the first h ad trem l cun s, b t cannot be h re gi n I ref to ch cases as th t of th art of num rati n, which, as M Tyl clearl sh w b ref re ce t th word till used in som places, rigi ted in counting th fi rs, first f hand and then of th th and la t l f th toes. We h traces f this in w decimal st m and in th Roman num als, wh re, aft th V wh h is supposed to be an abbrev ted p cture of human hand w pass n to VI, &c., wh n the ther hand d bt was used So gain, When w peak f three score and t n, w are counting by th gesimal t m, ach score thus ideally mad tand g f 20—f man as M xican Carib w ld p t t.[36] According to lar and reasi g school of philologists, ry languag bears th marks of ts low and grad al l t n. So t with th art of writi g, f l tt rs are rudim ts of p torial representati ns. It is hardl possibl t read M M Lennan w k[37] and t admit that alm t all lised nat ns still retain trace of uch rud hab ts as th f rcibl cap t re of wi s. What ancient nat n, as th sam thor asks, can be named that was riginally m n gam us Th primiti e idea of j l wnl y th l w of battl and other beli fs. The highe t f rm of rel gi n—the grand d of God hating sin and l ving righteo sn ss—was unkn wn during prime al tim s.

T rni g t the the kind of evidence Sir J L bbock has shewn that som sa a s h recently impro ed littl in som of th r simpl r arts. From the tremely uri us count which h f the w apons, tools, and arts, in se am ng t sa age n ari u parts f th w ld t ca n t be doubted that th se have n arly all been i d pendent disco ri s, cept pe h ps th art f maki fire.[38] Th Au tralian boome an s good nstance f one such d pend nt disco ry The Tahit ans when fi t visited had ad anced n man re pects be nd th nh b tants of m t f the th P l nesian islands. Th re are n ju t ground f th beli f that th high cult re of th n ti P ruvians and M xicans was de ri ed from abroad;[39] many nat plant w re th re cultiv ted, and f w n ti animals do mest cated W sh uld bear in mi d that, judging from th small nfl ce f m t mis si nari s, wand ring crew from som semi civilised land if washed t th sh res f Am ca, wo ld not h produced any marked ffect on the nati es, unless th y had already inhab tants retai no trad t n Th re also i direct d ce f th f rm use by th Chi ese and anci t J ws. H ce th re can hardl be d bt th t th nhab tant of these co tri s, which includ arly th wh l ci lised w ld w re nce in a barbaro con

Ro l Institution f Gr at Britain, March 15, 1867 Also R searche nto the Early History f the Class, y tem of Rela onsh p. Proc Amer ica Acad of Science ol. ii, I b 1868. Prof Schaaffha se Anth polog Review Oct., 1869 p. 373 rema ks the est ges f h ma sacrifices found both Homer nd the Old Testam t.

[38] Sir J Lubbock, Pr historic T me 2 d ed., 1869 haps od i et passim See also th ex celle t 9th hapt Tylo Ea ly History f Man kind, 2 d ed., 15 0.

[39] Dr F Muller has mad som good remarks to this ffect th Reis der Nova Anthropolog Theil, Abtheil iii., 1868, s. 127

dition To believe that man was aboriginally civilised and then suffered utter degradation in so many regions is to take a pitiably low view of human nature It is apparently a truer and more cheerful view that progress has been much more general than retrogression that man has risen though by slow and interrupted steps from a lowly condition to the highest standard as yet attained by him in knowledge morals and religion

CHAPTER VI

ON THE AFFINITIES AND GENEALOGY OF MAN

Even if it be granted that the difference between man and his nearest allies is as great in corporeal structure as some naturalists maintain, and although we must grant that the difference between them is immense in mental power, yet the facts given in the earlier chapters appear to declare, in the plainest manner, that man is descended from some lower form, notwithstanding that connecting links have not hitherto been discovered.

Man is liable to numerous, slight, and diversified variations, which are induced by the same general causes, are governed and transmitted in accordance with the same general laws, as in the lower animals. Man has multiplied so rapidly, that he has necessarily been exposed to struggle for existence, and consequently to natural selection. He has given rise to many races, some of which differ so much from each other, that they have often been ranked by naturalists as distinct species. His body is constructed on the same homological plan as that of other mammals. He passes through the same phases of embryological development. He retains many rudimentary and useless structures, which no doubt were once serviceable. Characters occasionally make their re-appearance in him, which we have reason to believe were possessed by his early progenitors. If the origin of man had been wholly different from that of all other animals, these various appearances would be mere empty deceptions; but such an admission is incredible. These appearances, on the other hand, are intelligible, at least to a large extent, if man is the co-descendant with other mammals of some unknown and lower form.

Some naturalists, from being deeply impressed with the mental and spiritual powers of man, have divided the whole organic world into three kingdoms, the Human, the Animal, and the Vegetable, thus giving to man a separate kingdom.[1] Spiritual powers cannot be compared or classed by the naturalist; but he may endeavour to shew, as I have done, that the mental faculties of man and the lower animals do not differ in kind, although immensely in degree. A difference in degree, however great, does not justify us in placing man in a distinct kingdom, as will perhaps be best illustrated by comparing the mental powers of two insects, namely, a coccus or scale-insect and an ant, which undoubtedly belong to the same class. The difference is here greater than, though of a somewhat different kind from, that between man and the highest mammal. The female coccus, whilst young, attaches itself by its proboscis to a plant; sucks the sap, but never moves again; is fertilised and lays eggs; and this is its whole history. On the other hand, to describe the habits and mental powers of worker-ants, would require, as Pierre Huber has shewn, a large volume; I may, however, briefly specify a few points. Ants certainly communicate information to each other, and several unite for the same work, or for games of play. They recognise their fellow-ants after months of absence, and feel sympathy for each other. They build great edifices, keep them clean, close the doors in the evening, and post sentries. They make roads as well as tunnels under rivers, and temporary bridges over them, by clinging together. They collect food for the community, and when an object, too large for entrance, is brought to the nest, they enlarge the door, and afterwards build it up again. They store up seeds, of which they prevent the germination, and which, if damp, are brought up to the surface to dry. They keep aphides and other insects as milch-cows. They go out to battle in regular bands, and freely sacrifice their lives for the common weal. They emigrate according to a preconcerted plan. They capture slaves. They move the eggs of their aphides, as well as their own eggs and cocoons, into warm parts of the nest, in order that they may be quickly hatched; and endless similar facts could be given.[2] On the whole, the difference in mental power between an ant and a coccus is immense; yet no one has ever

[1] Isidore Geoffroy St.-Hilaire gives a detailed account of the position assigned to man by various naturalists in their classifications: *Hist. Nat. Gén.* tom. ii., 1859, pp. 170-189.

[2] Some of the most interesting facts ever published on the habits of ants are given by Mr. Belt, in his *The Naturalist in Nicaragua*, 1874. See also Mr. Moggridge's admirable work, *Harvesting Ants, &c.*, 1873, also L'Instinct chez les Insectes, by M. George Pouchet, *Revue des Deux Mondes*, Feb., 1870, p. 682.

dreamed of placing these insects in distinct classes much less in distinct kingdoms No doubt the difference is bridged over by other insects and this is not the case with man and the higher apes But we have every reason to believe that the breaks in the series are simply the results of many forms having become extinct

Professor Owen relying chiefly on the structure of the brain has divided the mammalian series into four sub classes One of these he devotes to man in another he places both the marsupials and the Monotremata so that he makes man as distinct from all other mammals as are these two latter groups conjoined This view has not been accepted as far as I am aware by any naturalist capable of forming an independent judgment and therefore need not here be further considered

We can understand why a classification founded on any single character or organ—even an organ so wonderfully complex and important as the brain—or on the high development of the mental faculties is almost sure to prove unsatisfactory This principle has indeed been tried with hymenopterous insects but when thus classed by their habits or instincts the arrangement proved thoroughly artificial [3] Classifications may of course be based on any character whatever as on size colour or the element inhabited but naturalists have long felt a profound conviction that there is a natural system This system it is now generally admitted must be as far as possible genealogical in arrangement —that is the co descendants of the same form must be *kept together in one group apart from the co-descendants of any other form* but if the parent forms are related so will be their descendants and the two groups together will form a larger group The amount of difference between the several groups—that is the amount of modification which each has undergone—is expressed by such terms as genera families orders and classes As we have no record of the lines of descent the pedigree can be discovered only by observing the degrees of resemblance between the beings which are to be classed For this object numerous points of resemblance are of much more importance than the amount of similarity or dissimilarity in a few points If two languages were found to resemble each other in a multitude of words and points of construction they would be universally recognised as having sprung from a common source notwithstanding that they differed greatly in some few words or points of construction But with organic beings the points of resemblance must not consist of adaptations to similar habits of life two animals may for instance have had their whole frames modified for living in the water and yet they will not be brought any nearer to each other in the natural system Hence we can see how it is that resemblances in several unimportant structures in useless and rudimentary organs or not now functionally active or in an embryological condition are by far the most serviceable for classification for they can hardly be due to adaptations within a late period and thus they reveal the old lines of descent or of true affinity

We can further see why a great amount of modification in some one character ought not to lead us to separate widely any two organisms A part which already differs much from the same part in other allied forms has already according to the theory of evolution varied much consequently it would (as long as the organism remained exposed to the same exciting conditions) be liable to further variations of the same kind and these if beneficial would be preserved and thus be continually augmented In many cases the continued development of a part for instance of the beak of a bird or of the teeth of a mammal would not aid the species in gaining its food or for any other object but with man we can see no definite limit to the continued development of the brain and mental faculties as far as advantage is concerned *Therefore in determining* the position of man in the natural or genealogical system the extreme development of his brain ought not to outweigh a multitude of resemblances in other less important or quite unimportant points

The greater number of naturalists who have taken into consideration the whole structure of man including his mental faculties have followed Blumenbach and Cuvier and have placed man in a separate Order under the title of the Bimana and therefore on an equality with the orders of the Quadrumana Carnivora &c Recently many of our best naturalists have recurred to the view first propounded by Linnæus so remarkable for his sagacity and have placed man in the same Order with the *Quadrumana* under the *title of the Primates* The justice of this conclusion will be admitted for in the first place we must bear

[3] Westwood *Modern Classification of Insects* vol. ii. 1840 p 87

in mind th comparati insignificance fo classificati of th gre t d el pm nt f th brain in man, and th t the tro gl marked d... rences between the skulls of man and th Quadrumana (latel insisted pon b Bisch ff Aeb and others) ppare tl f llow from th ir d... rently d loped brains. In th second place w must rem mbe that n arl all th other and more important diff re ces between man and th Quadrumana are manif tl ad p- t th nature and relat chi fly t th

of seals

importance f ad pti haract rs f classifi- cati n. These animals diff r from all th r Carnivora in th f rm of th ir bodies and th truct re of th ir limbs, far m re than does man from th hi h pes v t in mo t s- t ms, from that of C t th mo t rece t b M Flow seals are ranked as m re family in th Ord of th Carni ora. If man had t bee hi wn classifi h w uld have tho ght of f unding a separat rd f r his wn recept n.

It would be be nd m limits, and quit be- yond m knowledg n t nam th n num rable points of stru ture in whi h man agrees with th th prim tes. Our gre t anatomist and phil soph Prof Huxl has full discussed thi subject, and co l d that man in all parts of his rganizat differs less from th high pes, than these d from the low m mbers of th sam gro p. Conse- quentl th re is n justificati n f placin man d tinct rs

In an earl part f this w k I bro ght f ward ano facts, h wi g how l sel man agree in const t ti with th high mam mals and this agreem t must d pend ur lose similarit mun t tructure and h m ical compos t n. I g as nstances, ur liabilit t th sam d seases, and t th tacks of all ed parasites our tastes in comm for th sam tim lants, and th similar ffects produced b them, as w ll as by ari us drugs, and other uch facts.

As mall nimportant points of resemblance bet ee man and th Quadrumana are not commonl noticed t matic works, and as, be umerous, the learly re eal ur re- lationship, I all peci f w uch points. The relati e posit n f our f tures is manif tly the sam and the vari us m ti ns are dis- played by m arl similar mov m nts of th muscle and skin, hi fly bo the brows and round the m th. Some few expressi ns deed lmo t th same as in th weeping

and in

ears are curi sly alik In man the n se is m ch m re promin t than in most monke b t w may trace th comme cem nt of an quilin curv ture n the nose f th Hoolock gibbon and thi in th *Semnop thecus nasica* carried to a ridiculous xtreme.

Th faces of many m mbers are ornam nted with beards, whisk rs, o mou taches. The hair n the h ad grow to a great l ngth in som peci f Semn p thecus and in the bo t m k y (*Macacus rad atus*) t radi tes

t al appearance b t the thick hair on the h ad of th bonn t m nk y t rmin tes down wards abruptl and cceeded by hair so sh rt and fin that t a littl distance th f re- h ad w th th exception f th y brows, ap- pears quit naked. It has been rro eo ly asserted th t ebrows are n t present in any m nk In th peci ju t named th d gree of nakedness f th f reh ad diff rs in diff rent indi d als and Eschri ht tates that in ou childre th limit between th hairy scalp and th naked f reh ad som times t w ll d fined so th t h re w seem t ha e a trifling case of re rsi n to pro nit in wh m th f reh ad had n t as t becom quite naked.

It is well known th t th hair on ou arms t nds t con rg from abo and below to a point t th lbow This curi us arrangement so unlik that in most f the l w mammals, is comm to th gorilla, chimpanzee orang, som species f Hylobates, and en to some f w Am rican monk ys. B t in *H. lobate gilis* th hai on th f re-arm directed d wnwards t wards th wrist n th ordinary mann and in *H lar* ar rect, w th onl a ry slight f rward inclinati so that in this latte species t in a transitional tate. It can hard

Proceed Zoological Soc 1863, p. 4.
Evidence as to M Place in Nature, 1863, p. 0, et passim.

Isidore Geoffroy st Hilaire Hist. Nat. G n., tom. ii, 1859 p. 21
Über die Richtung der Haare, &c., Müller Archiv fur Anat. nd Phy 183 s. 51.

ly be doubted that with most mammals the thickness of the hair on the back and its direction is adapted to throw off the rain even the transverse hairs on the fore legs of a dog may serve for this end when he i coiled up asleep Mr Wallace who has carefully studied the habits of the orang remarks that the convergence of the hair towards the elbow on the arms of the orang may be explained as serving to throw off the rain for this animal during rainy weather sits with its arms bent, and with the hands clasped round a branch or over its

seems probable the direction of the hair on our own arms offers a curious record of our former state for no one supposes that it is now of any use in throwing off the rain nor in our present erect condition is it properly directed for this purpose

It would however be rash to trust too much to the principle of adaptation in regard to the direction of the hair in man or his early progenitors for it is impossible to study the figures given by Eschricht of the arrangement of the hair on the human fœtus (this being the same as in the adult) and not agree with this excellent observer that other and more complex causes have intervened The points of convergence seem to stand in some relation to those points in the embryo which are last closed in during development There appears also to exist some relation between the arrangement of the hair on the limbs and the course of the medullary arteries [9]

It must not be supposed that the resemblances between man and certain apes in the above and in many other points—such as in having a naked forehead long tresses on the head &c —are all necessarily the result of unbroken inheritance from a common progenitor or of subsequent reversion Many of these resemblances are more probably due to analogous variation which follows as I have else where attempted to shew from co-descended organisms having a similar constitution and having been acted on by like causes inducing similar modifications With respect to the similar direction of the hair on the fore arms of man and certain monkeys as this character is common to almost all the anthropomorphous apes it may probably be attributed to inheritance but this is not certain as some very distinct American monkeys are thus characterised

Although as we have now seen man has no just right to form a separate Order for his own reception he may perhaps claim a distinct sub order or family Prof Huxley in his last work [11] divides the primates into three sub-orders

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genera of lemurs As far as differences in certain important points of structure are concerned man may no doubt rightly claim the rank of a sub order and this rank is too low if we look chiefly to his mental faculties Nevertheless from a genealogical point of view it appears that this rank is too high and that man ought to form merely a family or possibly even only a sub family If we imagine three lines of descent proceeding from a common stock it is quite conceivable that two of them might after the lapse of ages be so slightly changed as still to remain as species of the same genus whilst the third line might become so greatly modified as to deserve to rank as a distinct sub family or even Order But in this case it is almost certain that the third line would still retain through inheritance numerous small points of resemblance with the other two Here then would occur the difficulty at present insoluble how much weight we ought to assign in our classifications to strongly marked differences in some few points —that is to the amount of modification undergone and how much to close resemblance in numerous unimportant points as indicating the lines of descent or genealogy To attach much weight to the few but strong differences is the most obvious and perhaps the safest course though it appears more correct to pay great attention to the many small resemblances as giving a truly natural classification

In forming a judgment on this head with reference to man we must glance at the classification of the Simiadæ This family is divided by almost all naturalists into the catarhine

[9] Quoted by R d African Sk tch Book v l i 1873 p 152

J A
1868, p 318

In I t oduct n to the Clas f tio f A mals
1869 p 99

gro p, or Old W ld m nkeys, all of which are charact rised (as th nam xp ses) by th peculiar tructure f th no trils, d by l I u premolars n ach j w and nto th platy l gro p N w W ld m nkey (ncluding t ery disti ct b g) all f l ch are charact rised by d ff rently con tru ted trils, and b b n ix prem lars ch w Som tl m lld ff ce might

f w f t m ch impo tance l ppare tly f an ad pt n t re It tl f re st all probab l ty that som N w W ld pecies sh uld ha f m ly aried and l p od ced a man lik cre ture w th all tl e d t ts haracters p pe t tl Old W ld d los g at th sam tim ll ts wn d ti ts l ct rs Tl an, co seq tl hardly b

th catarhi d us n.[18]

Th anth pom rpl pes, nam ly the g lla, chimpanzee, ang and Hyl b tes, are by m t nat al t separ ted from th th Old W ld monkeys, as a dist t b-gro p I am ar th t G t l t, ly g n th tru t re f th b ain, doe n t admit the xi t nce f th b-gro p and no d bt t a brok Th th ang, as M St. G Mi art remarks, f th most pec liar and aberrant f rm to be f d th Ord Th remai g anthropom rpl us Old W ld m k ys, are agai di ided by som nat ralist t t three mall b-gro ps tl g S mn p thecus, w th ts peculiar sacc lated t mach being th type f ne b-gro p ll t t ppears from M Gau dry d ri l disc n Att ca, that l n g tl M occ period f rm isted th re wl h co ected Semn p thecus nd Macacus and tl probably ll tr te th

mann which th oth and high r groups w re c ble ded togeth r

If th nthropom ph pes be admitted to f rm nat l b-group th n s m n f th m t nly n all th se char

nfe th t so e an t m mber of th a thropom rph s ub p g b rth t man. It is n t prob bl that, thr gh th l w of al g r ti n, m mbe f o f th oth l w r b-gro p sl ld h n se to a man lik er atu r sembli g the l gh anth pomo ph u p in so many re pects N o d l t m comp riso with most of his

th t l s but f seve al e cept al f m f prim tes

E y n t ali t who b l e e n th pri cipl f l tion, w ll g ant tl at the tw main di is ns f th Simiadæ nam ly the cata-rh and platy h m nk y s, with thei b-gro ps, h ll proceeded from som e trem ly a at prog nit Th arly d

gro p b t som f th peci s r incip nt g n er w uld h l eady b gun to indicat by th i di ging charact rs the f ture d t t marks of th catarh e and pl tyrhi e d ns. H th m mb f thi pposed anc t gro p wo ld n t h been so uniform th d nt ti n, th tr cture f th ir n t ls, as ar th xisti g catarhin m nk in new y and th pl ty hi es in an th w y b t w ld h resembled in th re pect th all ed Lem ridæ wl ch diff gre tly from ach th in th f rm f th ir muzzl s, and to an t ao dinary d g ee n th r d tit n

Th cata hin and pl ty hine m nk y gree m ltit d f characters, as sh wn by th unq est onably bel gin t and th sam Ord Th many charact rs wh h th y possess comm ca hardly h b nd pend ntly acquired by so many dist ct peci s so th t these charact rs m t ha

l Ir these t latter gro ps ns ern g t th l la y hine M M rt till b des by th same w see Nat 1871 p 4 1

Transactions, Zoolog Soc., vol. , 1867 214

Mr St. G M art, T nsactions f the Pl ilosoph ical Society 1867 p 410

Messrs. Muric d M art the Lemuro dea, Transact ns Zoological Society L n, 1869 p 5

been inherited But a naturalist would undoubtedly have ranked as an ape or a monkey an ancient form which possessed many characters common to the catarhine and platyrhine monkeys other characters in an intermediate condition and some few perhaps distinct from those now found in either group And as man from a genealogical point of view belongs to the catarhine or Old World stock we must conclude however much the conclusion may revolt our pride that our early progenitors would have been properly thus designated [18] But we must not fall into the error of supposing that the early progenitors of the whole simian stock including man was identical with or even closely resembled any existing ape or monkey

On the Birthplace and Antiquity of Man — We are naturally led to enquire where was the birthplace of man at that stage of descent when our progenitors diverged from the catarhine stock? The fact that they belonged to this stock clearly shews that they inhabited the Old World but not Australia nor any oceanic island as we may infer from the laws of geographical distribution In each great region of the world the living mammals are closely related to the extinct species of the same region It is therefore probable that Africa was formerly inhabited by extinct apes closely allied to the gorilla and chimpanzee and as these two species are now man s nearest allies it is somewhat more probable that our early progenitors lived on the African continent than elsewhere But it is useless to speculate on this subject for two or three anthropomorphous apes one the Dryopithecus of Lartet nearly as large as a man and closely allied to Hylobates, existed in Europe during the Miocene age and since so remote a period the earth has certainly undergone many great revolutions and there has been ample time for migration on the largest scale

At the period and place whenever and wherever it was when man first lost his hairy covering he probably inhabited a hot country a circumstance favourable for the frugi

Hi l ha com

ferous diet on which judging from analogy he subsisted We are far from knowing how long ago it was when man first diverged from the catarhine stock but it ma h

l as early as th

may be modified under favourable circumstances we know however that some have retained the same fo

at all some a little and some greatly changed all within the same period Thus it may have been with man who has undergone a great amount of modification in certain characters in comparison with the higher apes

The great break in the organic chain between man and his nearest allies which cannot be bridged over by any extin t o

ppear of much weight to those who from general reasons believe in the general principle of evolution Breaks often occur in all parts of the serie some being wide sharp and defined others less so in various degrees as between the orang and its nearest allies—between the Tarsius and the other Lemuridæ—between the elephant and in a more striking manner between the Ornithorhynchus or Echidna and all other mammals But these breaks depend merely on the number of related forms which have become extinct At some future period not very distant as measured by centuries the civilised races of man will almost certainly exterminate and replace the savage races throughout the world At the same time the anthropomorphous apes as Professor Schaaffhausen has remarked [19] will no doubt be exterminated The break between man and his nearest allies will then be wider for it will intervene between man in a more civilised state as we may hope even than the Caucasian and some ape as low as a baboon instead of as now between the negro or Australian and the gorilla.

With respect to the absence of fossil remains serving to connect man with his ape like progenitor no one will lay much stress on this

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18 ... Dr C F Forsyth Major Sur les singes fossiles trouvés en Italie *Soc Ital. des Sc. Nat.*, t xv 16 ...

19 *Anthropological Review* April, 1867 p 236.

fact wh read S r C Ly ll d scuss ts t wl re h sl thatı all th ert b t classe th disco ery ff ss l remains has been a ry l w and f rt t us process. N r ho ld t be t f g tt th t tl se reg s wl ch are the t most lik l t aff rd rem ns connect g man w th som t t pe l k reature h n t as y t bee se rched by geol gists.

Low St g the Gen alogy f M —We h see that man ppear to h e d r ed from th catarh Old W ld d n f tl S m adæ aft th e had di e ged from the New W ld d We will w d ur t f ll w th rem te t aces f h s g n al gy trusti g pri cipally t th m t al affinit be-twee tl n s classes nd rd rs, w th som l ght f ce t tl periods, as far as

t Haeck l d th rs, di tin t Ord l h gro p d rsified and brok n t an tra rd nary d gree and l d many be ant f rms. It has, th ref re prol ably ff red m l t ct M t f tl rem ants lands, h as Mad gascar and tl Mal yan arcl pel g wl re th y h e t bee posed t so se re compet ti n as th y w ld ha bee w ll tocked co f

a. a.

tl re b t t p as t seems, t th l est, mallest and l ast t ll g t f tl place tal mammal a. From tl se arı consid a. t t prol abl th t tl S m adæ w re g all d loped from th p g nit rs f th x ti g Lem dæ d th se th t m from f rms tand ry l w in th mam mal an seri s.

Tl mars p ls tand mans mport t haract rs below tl place tal mammals Th y ppeared t an arl geol g al period and th ang was f rm l m l m re t tl an t prese t H ce tl l lace t t are rall ppos l t l bee l n ed from tl Im place tata mars p als n t l from f rms losel resembl g th t g mars p ls, t t from tl l prog tor Tl M notrem t are plai ly all ed t

f ble co currence of circ m tances

re t ...

In attempti g to t ace tl genealogy of tl e Mammalia, and th f f man, l w r d n a the ser s, w become n l ed n great r and gre t obscurity b t as a mo t cap ble

H wh wi he to see wh t ing nity nd knowledg can ffect, m y consult Prof H ec kel w ks.[32] I will cont nt myself with fe g n al remarks. E ry l t om t will dm t th t th fi gre t rt brate classes, nam l m mmals, b rds, reptil s, amph bians d fish s, are d sce ded fro i som ne proto-type f tl y ha m ch n common s pec ally dur g th mb yo tat As tl e class f fish th m t l wly o ganised and ppeared b f re th th s, w may co l d that ll th m mbers of th rtebrat ki g d m re d n ed from some fishlik anım l Th beh f th t animal so d ti ct as a mo k an lephant h mming b rd a ak a frog and fi h &c. co ld all h prung from th sam pare ts, w ll ppear m t u to th se wh ha n t tt nded t th rec t progress f nat al hı t ry F thi bel f m pl es th former t nce of links b d g l sely t g th all th se fo ms, n w so utte ly u ll k

N rtl l ss ı ec ta that gro ps of animals h ted d now xist, which se to co ect se l f th great rte b t lasse m re l ss l sel We h e seen tl t th Orn th hy ch g ad tes towards rept les and Prof Huxl y has d sco ed d confirmed by M Cope and thers, th t tl

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lements of Geology 1865 pp. 583-585 *Ant quity of M n*, 1 8, p 145

M *l is Nat* p. 105.

El bo t t bles ar g1 his *Gener ll Mor phol g* (B s. ch d s. 425) and w th m re espec lref cet ıa his *Nat liche Schöpf gs-g schichte* 1868 Prof Huxl y re g this latt w k (*Th Acad y* 1869 p 42) say that h cons d rs th phyl m l of desce t f th V te-brat t be dm rably discus ed by Haeck l l though he d ff rs som po ts. H expresses, lso his h gh est m t f th g al t d pi t f the hol ork.

dinosaurians are in many important characters intermediate between certain reptiles and certain birds—the birds referred to being the ostrich tribe (itself a widely diffused remnant of a larger group) and the Archeopteryx, that strange secondary bird, with a long lizard-like tail. Again, according to Prof. Owen,[22] the ichthyosaurians—great sea-lizards furnished with paddles—present many affinities with fishes, or rather, according to Huxley, with amphibians; a class which, including in its highest division frogs and toads, is plainl

fied affinities with other groups of organisms. The Lepidosiren is also so closely allied to amphibians and fishes, that naturalists long disputed in which of these two classes to rank it; it, and also some few ganoid fishes, have been preserved from utter extinction by inhabiting rivers, which are harbours of refuge, and are related to the great waters of the ocean in the same way that islands are to continents.

Lastly, one single member of the immense and diversified class of fishes, namely, the lancelet or amphioxus, is so different from all other fishes, that Haeckel maintains that it ought to form a distinct class in the vertebrate kingdom. This fish is remarkable for its negative characters; it can hardly be said to possess a brain, vertebral column, or heart, &c.; so that it was classed by the older naturalists amongst the worms. Many years ago Prof. Goodsir perceived that the lancelet presented some affinities with the ascidians, which are invertebrate, hermaphrodite, marine creatures permanently attached to a support. They hardly appear like animals, and consist of a simple, tough, leathery sack, with two small projecting orifices. They belong to the Mulluscoida of Huxley—a lower division of the great kingdom of the Mollusca; but they have recently been placed by some naturalists amongst the Vermes or worms. Their larvæ somewhat resemble tadpoles in shape,[23] and have the power of swimming freely about. Mr. Kovalevsky[4] has lately observed that the larvæ of ascidians are related to the Verte-

has now carried these observations yet further, and should his results be well established, the whole will form a discovery of the very greatest value. Thus, if we may rely on embryology, ever the safest guide in classification, it seems that we have at last gained a clue to the source whence the Vertebrata were derived.[24] We should then be justified in believing that at an extremely remote period a group of animals existed, resembling in many respects the larvæ of our present ascidians, which diverged into two great branches—the one retrograding in development and producing the present class of ascidians, the other rising to the crown and summit of the animal kingdom by giving birth to the Vertebrata.

We have thus far endeavoured rudely to trace the genealogy of the Vertebrata by the aid of their mutual affinities. We will now look to man as he exists; and we shall, I think, be able partially to restore the structure of our early progenitors, during successive periods, but not in due order of time. This can be ef-

version, and by the aid of the principles of morphology and embryology. The various facts, to which I shall here allude, have been given in the previous chapters.

The early progenitors of man must have been once covered with hair, both sexes having

... transverse ... partitions, which I presume rep-

beards; their ears were probably pointed, and capable of movement; and their bodies were provided with a tail, having the proper muscles. Their limbs and bodies were also acted on by many muscles which now only occasionally reappear, but are normally present in the Quadrumana. At this or some earlier period, the great artery and nerve of the humerus ran through a supra-condyloid foramen. The intestine gave forth a much larger diverticulum or caecum than that now existing. The foot was then prehensile, judging from the condition of the great toe in the foetus; and our progenitors, no doubt, were arboreal in their habits, and frequented some warm, forest-clad land. The males had great canine teeth, which served them as formidable weapons. At a much earlier period the uterus was double; the excreta were voided through a cloaca; and the eye was protected by a third eyelid or nictitating membrane. At a still earlier period the progenitors of man must have been aquatic in their habits; for morphology plainly tells us that our lungs consist of a modified swimbladder, which once served as a float. The clefts on the neck in the embryo of man show where the branchiae once existed. In the lunar or weekly recurrent periods of some of our functions we apparently still retain traces of our primordial birthplace, a shore washed by the tides. At about this same early period the true kidneys were replaced by the corpora wolffiana. The heart existed as a simple pulsating vessel; and the chorda dorsalis took the place of a vertebral column. These early ancestors of man, thus seen in the dim recesses of time, must have been as simply or even still more simply organised than the lancelet or amphioxus.

There is one other point deserving a fuller notice. It has long been known that in the vertebrate kingdom one sex bears rudiments of various accessory parts, appertaining to the reproductive system, which properly belong to the opposite sex; and it has now been ascertained that at a very early embryonic period both sexes possess true male and female glands. Hence some remote progenitor of the whole vertebrate kingdom appears to have been hermaphrodite or androgynous.[38] But here we encounter a singular difficulty. In the mammalian class the males possess rudiments of a uterus with the adjacent passage, in their vesiculae prostaticae; they bear also rudiments of mammae, and some male marsupials have traces of a marsupial sack.[39] Other analogous facts could be added. Are we, then, to suppose that some extremely ancient mammal continued androgynous, after it had acquired the chief distinctions of its class, and therefore after it had diverged from the lower classes of the vertebrate kingdom? This seems very improbable, for we have to look to fishes, the lowest of all the classes, to find any still existent androgynous forms.[40] That various accessory parts, proper to each sex, are found in a rudimentary condition in the opposite sex,

this form of transmission,—as in the case of the spurs, plumes, and brilliant colours, acquired for battle or ornament by male birds, and inherited by the females in an imperfect or rudimentary condition.

The possession by male mammals of functionally imperfect mammary organs is, in some respects, especially curious. The Monotremata have the proper milk-secreting glands with orifices, but no nipples; and as these animals stand at the very base of the mammalian series, it is probable that the progenitors of the class also had milk-secreting glands, but no nipples. This conclusion is supported by what is known of their manner of development; for Professor Turner informs me, on the authority of Kölliker and Langer, that in the embryo the mammary glands can be distinctly traced before the nipples are in the least visible; and the

[38] This is the conclusion of Prof. Gegenbaur, one of the highest authorities in comparative anatomy: see 'Grundzüge der vergleich. Anat.' 1870, s. 876. The result has been arrived at chiefly from the study of the Amphibia; but it appears from the researches of Waldeyer (as quoted in 'Journal of Anat. and Phys.' 1869, p. 161), that the sexual organs of even "the higher vertebrata are, in their early condition, hermaphrodite." Similar views have long been held by some authors, though until recently without a firm basis.

[39] The male Thylacinus offers the best instance. Owen, 'Anatomy of Vertebrates,' vol. iii. p. 771.

[40] Hermaphroditism has been observed in several species of Serranus, as well as in some other fishes, where it is either normal and symmetrical, or abnormal and unilateral. Dr. Zouteveen has given me references on this subject, more especially to a paper by Prof. Halbertsma, in the 'Transact. of the Dutch Acad. of Sciences,' vol. xvi. Dr. Günther doubts the fact, but it has now been recorded by too many good observers to be any longer disputed. Dr. M. Lessona writes to me, that he has verified the observations made by Cavolini on Serranus. Prof. Ercolani has recently shewn ('Accad. delle Scienze,' Bologna, Dec. 28, 1871) that eels are androgynous.

development of successive parts in the individual generally represents and accords with the development of successive beings in the same line of descent. The marsupials differ from the Monotremata by possessing nipples, so that probably these organs were first acquired by the marsupials after they had diverged from, and risen above, the Monotremata, and were then transmitted to the placental mammals.[79] No one will suppose that the marsupials still remained androgynous after they had approximately acquired their present structure. How then are we to account for male mammals possessing mammæ? It is possible that they were first developed in the females and then transferred to the males, but from what follows this is hardly probable.

It may be suggested, as another view, that long after the progenitors of the whole mammalian class had ceased to be androgynous, both sexes yielded milk, and thus nourished their young; and in the case of the marsupials, that both sexes carried their young in marsupial sacks. This will not appear altogether improbable, if we reflect that the males of existing syngnathous fishes receive the eggs of the females in their abdominal pouches, hatch them, and afterwards, as some believe, nourish the young;[80]—that certain other male fishes hatch the eggs within their mouths or branchial cavities;—that certain male toads take the chaplets of eggs from the females, and wind them round their own thighs, keeping them there until the tadpoles are born;—that certain male birds undertake the whole duty of incubation, and that male pigeons, as well as the females, feed their nestlings with a secretion from their crops. But the above suggestion first occurred to me from mammary glands of male mammals being so much more perfectly developed than the rudiments of the other accessory reproductive parts, which are found in the one sex though proper to the other. The mammary glands and nipples, as they exist in male mammals, can indeed hardly be called rudimentary; they are merely not fully developed, and not functionally active. They are sympathetically affected under the influence of certain diseases, like the same organs in the female. They often secrete a few drops of milk at birth and at puberty: this latter fact occurred in the curious case before referred to, where a young man possessed two pairs of mammæ. In man and some other male mammals these organs have been known occasionally to become so well developed during maturity as to yield a fair supply of milk. Now if we suppose that during a former prolonged period male mammals aided the females in nursing their offspring,[81] and that afterwards from some cause (as from the production of a smaller number of young) the males ceased to give this aid, disuse of the organs during maturity would lead to their becoming inactive; and from two well-known principles of inheritance, this state of inactivity would probably be transmitted to the males at the corresponding age of maturity. But at an earlier age these organs would be left unaffected, so that they would be almost equally well developed in the young of both sexes.

Conclusion.—Von Baer has defined advancement or progress in the organic scale better than any one else, as resting on the amount of differentiation and specialisation of the several parts of a being,—when arrived at maturity, as I should be inclined to add. Now as organisms have become slowly adapted to diversified lines of life by means of natural selection, their parts will have become more and more differentiated and specialised for various functions from the advantage gained by the division of physiological labour. The same part appears often to have been modified first for one purpose, and then long afterwards for some other and quite distinct purpose; and thus all the parts are rendered more and more complex. But each organism still retains the

geological evidence, that organisation on the whole has advanced throughout the world by slow and interrupted steps. In the great king

79 Prof. Gegenbaur has shewn (*Jen[illegible] Zeitschrift*, Bd. [illegible] p. 212) that [illegible] distinct types of nipples prevail throughout the several mammalian orders, but that it is quite intelligible how both could have been derived from the nipples of the marsupials, and the latter from those of the Monotremata. See also a memoir by Dr. M[illegible] Huss, on the mammary glands, *ibid.* [illegible] p. 1[illegible]6.

80 Mr. Lockwood b[illegible] (as quoted in *Quart. Journal of Science*, April 1868, p. 269), from what he has observed of the development of Hippocampus, [illegible] the walls of the abdominal pouch of the male in [illegible]

[illegible] *Anatomy and Physiology*, [illegible] 1866, p. [illegible]8. Dr. Günther has likewise described similar cases.

81 Mlle. C. Royer has suggested a similar view in her *Origine de l'homme*, &c., 1870.

d m of the V rt brata t has culminated n man. It mu t t, h w be pposed that gro p f organic be g are alw ys pplanted and disap pear as soo as th ha e gi n b rth t th and m re perfect gro ps. Th latt r tho gh ctori us th predecessors, t h become bett adapted f all

posed t ery se re competiti n and n se oft aid us in constru ti g ur g al gi s, by gi ing us fair d f f rm and lost populati ns. B t e must n t fall into th ror f looki g t th xi ting m mbers f any l wly rganised group as perfect represent ti es f th ir anci t p edecessors.

Th m t ancient prog nit rs in th ki d m of th V rtebrata, t which w are abl to obtai an bscure glance ppare tly consisted f gro p f mari animals,[38] resemblin th larv f xi ti g asc d ans. These animals prob bly g rise to gro p of fishes, as lo l gan sed as the lancel t and from th se th gan ds, and th fis es l k th Lep dosiren m t ha bee d loped From s ch fish ry small ad ance w ld carry us to tl amphibians. W h see th t b rd and reptiles w re ce timat ly connected to g th and th M trem ta n w connect mammals th reptiles slight d gree. B t no can at present say by wh t lin f de-

scent the three high r and related classes, nam ly mammals, birds, and reptiles, were d ri ed from the two l w r vert br t classes, namely amphib ans and fishes. In the class of mammal th st p are n t difficult to con ce which led from th ancient M notremata t the anci nt mar p als and from th se to th arly progenit rs of th placental mam mals. W may thus ascend t the Lemuridæ and the t al n t ry wide from th se to th Simiadæ. The Simiadæ then b anched off int tw gre t tems, the N w W ld and Old Wo ld m nk ys and from the latter t re m t period Man, th w d and gl ry of th Un rse proceeded

Th we h en to man a pedigree of prod us l ngth b t n t, it may be said f n bl q ality Th w rld it has often been remarked ppears as f it had l ng been pre n r f th ad nt f man and this, in on

h e been exactly wh t he n w s. Unl ss w wilfully cl se ur yes, w m y with ur present kn wled e, pproxim t ly recognise o pare tag eed we feel ashamed of t. Th m t humbl ganism somethin much

stru t re and properti s.

[38] The habita ts of th seashore must be greatly affected by th t des male li gether by t th me high- ter mark, or bo t the me low w t mark, pass thro gh compl t cycl of tidal cha ges

the course regular eekly perioda. N w t is m erious fact that in the h gh d ow t rrestrial Vert brata, as ll as ther lasses, ma y normal nd b ormal processes ha e more hole eeks as th ir periods thus ld be rend red ll ble if the Vert brata re desce ded from mal allied the ex t g tidal ascidia M y instances of h periodic processes m ght be gi n, b est t of mammals, the dur tio of f ers, &c. The hatchi g of ggs affords also good ex

mpl for according t M Bartlett (*Land nd Water* J n. 7 18 1), th ggs of the p geo re h tched tw weeks those of th f wl three those of th d k f ur those f th goose fi

CHAPTER VII

ON THE RACES OF MAN

It is not my intention here to describe the several so called races of men but I am about to enquire what is the value of the differences between them under a classificatory point of view and how they have originated In determining whether two or more allied forms ought to be ranked as species or varieties naturalists are practically guided by the following considerations namely the amount of difference between them and whether such differences relate to few or many points of structure and whether they are of physiological importance but more especially whether they are constant Constancy of character is what is chiefly valued and sought for by naturalists Whenever it can be shewn or rendered probable that the forms in question have remained distinct for a long period this becomes an argument of much weight in favour of treating them as species Even a slight degree of sterility between any two forms when first crossed or in their offspring is generally considered as a decisive test of their specific distinctness and their continued persistence without blending within the same area is usually accepted as sufficient evidence either of some degree of mutual sterility or in the case of animals of some mutual repugnance to pairing

Independently of fusion from intercrossing the complete absence in a well investigated region of varieties linking together any two closely allied forms is probably the most important of all the criterions of their specific distinctness and this is a somewhat different consideration from mere constancy of character for two forms may be highly variable and yet not yield intermediate varieties Geographical distribution is often brought into play unconsciously and sometimes consciously so that forms living in two widely separated areas in which most of the other inhabitants are specifically distinct are themselves usually looked at as distinct but in truth this affords no aid in distinguishing geographical races from so called good or true species

Now let us apply these generally admitted principles to the races of man viewing him in the same spirit as a naturalist would any other animal In regard to the amount of difference between the races we must make some allowance for our nice powers of discrimination gained by the long habit of observing ourselves. In India as Elphinstone remarks, although a newly arrived European cannot at first distinguish the various native races yet they soon appear to him extremely dissimilar [1] and the Hindoo cannot at first perceive any difference between the several European nations. Even the most distinct races of man are much more like each other in form than would at first be supposed certain negro tribes must be excepted whilst others as Dr Rohlfs writes

lection *Anthropologique du Muséum de Paris* of the men belonging to various races the greater number of which might pass for Europeans as many persons to whom I have shewn them have remarked Nevertheless, these men if seen alive would undoubtedly appear very distinct so that we are clearly much influenced in our judgment by the mere colour of the skin and hair by slight differences in the features and by expression

There is however no doubt that the various races when carefully compared and measured differ much from each other —as in the texture of the hair the relative proportions of all parts of the body [2] the capacity of the lungs, the form and capacity of the skull and even in the convolutions of the brain [3] But it would be an endless task to specify the numerous points of difference The races differ also in constitution in acclimatisation and in liability to certain diseases Their mental characteristics

[1] *History of India* 1841 vol. i p 323 Father Ripa makes exactly the same remark with respect to the Chinese

[2] A vast number of measurements of Whites, Blacks, and Indians, are given in the *Investigations in the Military and Anthropolog. Statistics of American Soldiers* by B A Gould 1869 pp 298-358 On the capacity of the lungs, p 471 See also the numerous and valuable tables by Dr Weisbach from the observations of Dr Scherzer and Dr Schwarz in the *Reise der Novara Anthropolog Theil* 1867

[3] See for instance Mr Marshall's account of the brain of a Bushwoman in *Philosophical Transactions* 1864 p 519

are likewise ery distinct chi fly as it w uld pear in their m ti nal, b t partl in their intellectual faculties. E ery who has had the pportunity of comparison, must ha been struck with th co trast between th taciturn, e en morose, aborigin s f S. Am rica and the lighthearted, talkati n groes. Th re is a nearl similar co trast between th Ma la s and th P puans, who li und the same pl sical conditi ns, and are separated from each th nly b narrow space of sea.

W will first consid th argum nts which may be ad anced in f ur f classing the races of man as distinct pecies, and then the argum ts on th other side. If nat ralist, who had ne er bef re seen N gro, Hottentot, A stralian, or M ngolian, w re to compare them, he w uld t nce perceive that the differed in multitud of characters, som of slight and som of considerable importance. On quiry h would find that th y were ad pted t li und wid ly diff rent climates, and that they diff red som what in bodil const t tio and m tal dispositi n. If h w re then told that hundreds of similar pecimens could be bro t from th same countries, h ould assuredl declare that th y were as good peci as man t which h had been in the hab t f affixin specific names. This conclusion w uld be gre tly tren thened as soo as he had ascertained that these f rms had all retained the sam character f many centuries and that groes, pparently identical th xisting negroes, had li ed at least 4000 ears ago. H would also h ar on th thor ty of an excell t obsers r Dr Lund that th h m k lls f und in th caves of Brazil

...

ably declare that those f rms mu t be di tinct pecies, which d ff n t only in ppearance b t are fitted f h t, as well as damp or dry countries, and f th arctic re ions. He m ht appeal to the fact that no species in th group n xt to man—namely the Quadrumana, can resi t a l w t mperature any consid rabl change of climat and that th speci which come n arest to man ha n r been reared to maturity n unde th tempe ate climate of Europe. H would be deeply impressed with th fact, first noticed by Agassiz, th t th diff rent races of man are distrib ted o the wo ld in th sam zool gical provinces, as th ose inhab ted b und ubtedl disti t pe-

...

mann r with th H tt t ts b t plainly with th P puans and Mala s, who are separated as Mr Wallace has sh wn, by n arl th same lin whi h divides th re t Malayan and Australian zoolo ical provinces. Th aborigines of Am rica ran e thro gh ut the co tin nt and this t first ppears opposed to the abo rul f most of th producti ns f th So th rn and North rn hal es differ widely t som f w livi forms, as th possum, ran from the e into th oth as did f m l som f th gi ants Ed ntata. Th Esq im ux, lik oth arct an m ls, extend ro nd the wh polar regions. It sh uld be observed that th am unt of diff rence bet ee th mammals of th se ral zool gical pro ince does n t correspo d w th th d ree of separati n b twee th l tt so that t can hardly be consid red as an an maly that th N gro d ff rs more and th Am rican m ch less from th oth races of man, than d th mammal of th African and Am rican con tin ts from th mammals of th oth r pro inces. Man, t may be added does not ppear t have aboriginally inhabited an ocean.

Wallace *The Malay Archipelago*, vol. ii, 1869 p. 178

With respect t the figures in the famous Egyptian ca es of Abou-simbel, M. Pouchet says (*The P ra of the H ma Races*, Eng transl., 1864 p. 50) that he as far from finding recognisable representati ns of the dozen or more nations which ome uthors be e tha they ca recogn se. E e

Ty es of Mankind, p. 14 stat that Rameses II, or he G e t, has features superbly European, hereas Knox, another firm believer in the specific distinctness of the races of ma *Race of M n*, 1850, p. 201) peaki g of young Memnon (the same as Rameses II, as I am formed by M Birch), insists in the stro est manner that he is identical in aracter ith the Jews of A t erp Again, he I l ked at the statue of Am noph III, I agreed th officers of the establishme t, both competent udges, that he had strongly-marked negro ype of f tures but Messrs. Nott and Gliddo (ibid., p. 146, fig. 53), describe him as hybrid, but not of negro intermixture.

As quoted by N tt and Gliddon, *Ty e of M nkind* 1854, p. 439 Th gi also corroborati evidence but C V gt th nks that the subject requires further in estigatio

On the Di ersity of Origin of th Human Races, in the *Christian Examiner* July 1850.

island and in this respect he resembles the other members of h ¹

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l „ or as specifically distinct that is whether any of them are descended from distinct wild species every naturalist would lay much stre ⁿ their ex tinct All act as it
„ xceptional one for I am informed by Mr Denny that the most different kinds of dogs fowls and pigeons in England are in fested by the same species of Pediculi or lice Now Mr A Murray has carefully examined the Pediculi collected in different countries from the different races of man [8] and he finds that they differ not only in colour but in the structure of their claws and limbs In every case in which many specimens were obtained the differences were constant The surgeon of a whaling ship in the Pacific assured me that when the Pediculi with which some Sandwich Islanders on board swarmed strayed on to the bodies of the English sailors they died in the course of three or four days These Pediculi were darker coloured and appeared different from those proper to the natives of Chiloe in South America of which he gave me speci mens These again appeared larger and much softer than European lice Mr Murray procured four kinds from Africa namely from the Negroes of the Eastern and Western coasts from the Hottentots and Kaffirs two kinds from the natives of Australia two from North and two from South America In these latter cases it may be presumed that the Pediculi came from natives inhabiting different dis tricts With insects slight structural differ ences if constant are generally esteemed of specific value and the fact of the races of man being infested by parasites which appear to be specifically distinct might fairly be urged as an argument that the races themselves ought to be classed as distinct species

Our supposed naturalist having proceeded thus far in his investigation would next en quire whether the races of men when cro se l were in any degree ste ile He might consult the work of Professor Broca a cautious and philosophical observer and in this he would find good evidence that some races were quite fertile together but evidence of an opposite nature in regard to other races Thus it has been asserted that the native women of Australia and Tasmania rarely produce children to European men the evidence however on this head has now been shewn to be almost valueless The half castes are killed by the pure blacks and an account has lately been published of eleven half caste youths murdered and burnt at the same time whose remains were found by the police [10] Ag n t l n been ¹

t pos tively as s that he has known mulatto families which have intermarried for several genera tions and have continued on an average ■ fertile as either pure whites or pure blacks. Enquiries formerly made by Sir C Lyell on this subject led him as he informs me to the same conclusion [12] In the United States the census for the year 18 4 included according to Dr Bachman 40, 7o1 mulattoes and this number considering all the circumstances of the case seems small but it may partly be ac counted for by the degraded and anomalous position of the class and by the profligacy of the women A certain amount of absorption of mulattoes into negroes must always be in progress and this would lead to an apparent diminution of the former The inferior vitality of mulattoes is spoken of in n t ustworthy wo k [and this, om their „ „ anced as

Tran actions of th Roy l Soc ty f Ed b gh, vol xxii 1861 p 67

O the Phenom n f Hyb idity n the Genus Homo E g tr nslat. 1864

s tt t r tingl tt r by M T A M rray n th Anth polog f R— 3

(n j q M r l 1869 p 239) mu h d that Au t ha n d Eu pe ns re n t t l l n er d

t Lx t f l f lg z St t h f the N t l ice f th t l B ld Ch rl t n 1855 p 44

D R l ff wr t n ctl t l f u d tl m ed rac n tl G t Sal r d n ed f m Ar bs, B B s, d N g oe f thr e tr b t rd r ly f rt l On tl tl r h d M W ood R d inl rm t H Coa t, toes, has r y as th M R de m n h f r h pl time

t ——— y B A G ald 1869 p 319 f Amer

a proof of the specific distinctness of th parent races. N d bt both animal and v getabl h brids, wh n prod ced from extrem ly distinct pec s, are liabl to prem ture d ath but the pare ts f mulattoe cann t be p t under th cat g ry f xtrem ly d ti ct pecies. The comm mul so n t n us f r l ng lif and vig ur and v t so t rile, h ws how littl ecessary connect n th re m hybrids bet een lesse ed f rtility and vitality th analo us cases co ld be cited

E n if t sh uld hereaft be pro ed th t all the aces f m w re perfectly f rtil tog th b h was inclined from the reasons to rank th m as d tin t pec s, might with justice argu th t f rt l ty and t rilit are n t saf rit ri na of pecifi disti tness. W kn w that these q lities are easil affected by chan ed cond ti ns f lif o b lose int breeding, and that th are g rned by h ghl compl l s, f instance that of th unequal f rtilit f co rse crosses between the sam t pecies. W th f rms which m t be anked a nd bted pecies, perfect se es xi t from tl se which are absol t ly t ril wh crossed, t th se which are lm t or compl t l f rtil Th d gree f t rility do not coincid tri tl w th tl degrees of dif f rence bet ee the parents ext rnal structures hab ts f lif Man man respects ma be compared with th se animals wh h ha lo g bee d mestic ted and larg body of id nce can be ad anced in f r of th Pallasian doctri th t d mest cat t ds

to eliminate the t rility which is so gen ral a result f the cross g f species n a tate of n ture. From these se ral consid rati ns, it m y be justly urged that th perfect fertility f th int rcrossed races f man, if established would not bsol t ly preclud us from anking th m d t n t pecies.

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parent f rms ught to be ranked as pecies or ari ties but afte carefully st dying th e d nce I ha e come t th conclus n that g ral rules of this kind can be trusted The rdinary result of a cross th produ tion of bl nded o intermedi te f rm b t n ce tain case some of the off pring tak cl sely aft r n pare t f rm, and som aft r the othe Th is e pecially pt to occu wh n th parents diff in characters which first ppeared as dd n ariati ns m nstrosities. I ref to this point, because D Rohlfs f rms me th t h has freq ntly seen in Africa th ff prin of n groes rossed with m mbers f th aces, th complet ly black o com pl t ly whit r arely p bald On the th r hand t is n t n us that in America mul t toes comm nly present an int rmedi te appearance.

W ha n w seen that a n turalist m ght feel himself fully j tified in rankin th aces f man as distin t species f h has f und th t th are distinguished b many diff nces in stru t re and constitution, som be ng f importance. These diff rences ha also remained n arly constant f r ry l g period f tim O turalist will ha been som d gree nfl ced by th n rm an f man, which is a gre t an maly in th class f mammals, if mankind be vi wed as a

Th V riat of Animals nd Pl nts nder Domestication, ol p. 109 I may here remi d the reader that the t rility of pecies be crossed is not specially acquired quali but, like the ncapacit of certai trees t be grafted t gether is incide al ther acquired differe ces. The nature of these differences is k n, b t they relat more especially be reproducti y tem and much less t rnal tructure or t ord nary differences con itio One import t le ine t th sterility of crossed pecies pparently l es both ha g bee g hab tuated t fi ed conditions f kno that hanged conditions ha special uence the reproducti e y tem, and we ha g d reas t belie as before remarked) tha be fluctuati g c ndi of domestication er l liminat that eril y h h is so general th species, in natural stat he crossed. It has been here bee she by me (ibid ol ii, p. 185, nd Origi of pecies, this ed., p. 142), that the sterili y of crossed species has t bee acquired hrough na ural selectio can see that be t forms ha already bee rendered ery sterile t is scarcely possible that their terility should be ug ment ed by the preserv tio or urv al of the more nd more sterile ind iduals for as the terili y increases, fewer nd fewer offspring ill be produced

from hi h t breed, nd t last nly single individuals will be produced the rarest tervals. B t there is hi her grad of terility tha this. Both Gart er nd Kolreut h pro ed that

lect the more terile individuals, which ha already ceased t yield seeds so that th acme of t rility he the germe alo is affected, can t ha bee gained through selection. This acme, and no doubt the other grades of terility are th incid l re sults of certain k diff re ces the constitution of the reproducti e y tem of th species hich are crossed.

The V riatio of Animals, &c ol ii, p 92.

single species. He will have been struck with the distribution of the several so-called races, which accords with that of other undoubtedly distinct species of mammals. Finally, he might urge that the mutual fertility of all the races has not as yet been fully proved, and even if proved would not be an absolute proof of their specific identity.

On the other side of the question, if our supposed naturalist were to enquire whether the forms of man keep distinct like ordinary species, when mingled together in large numbers *in the same country*, he would immediately discover that this was by no means the case. In Brazil he would behold an immense mongrel population of Negroes and Portuguese; in Chiloé and other parts of South America, he would behold the whole population consisting of Indians and Spaniards blended in various degrees.[16] In many parts of the same continent he would meet with the most complex crosses between Negroes, Indians, and Europeans; and judging from the vegetable kingdom, such triple crosses afford the severest test of the mutual fertility of the parent forms. In one island of the Pacific he would find a small population of mingled Polynesian and English blood; and in the Fiji Archipelago a population of Polynesians and Negritos crossed in all degrees. Many analogous cases could be added; for instance, in Africa. Hence the races of man are not sufficiently distinct to inhabit the same country without fusion; and the absence of fusion affords the usual and best test of specific distinctness.

Our naturalist would likewise be much disturbed as soon as he perceived that the distinctive characters of all the races were highly variable. This fact strikes every one on first beholding the negro slaves in Brazil, who have been imported from all parts of Africa. The same remark holds good with the Polynesians, and with many other races. It may be doubted whether any character can be named which is distinctive of a race and is constant. Savages, even within the limits of the same tribe, are not nearly so uniform in character, as has been often asserted. Hottentot women offer certain peculiarities, more strongly marked than those occurring in any other race, but these are known not to be of constant occurrence. In the several American tribes, colour and hairiness differ considerably; as does colour to a certain degree, and the shape of the features greatly, in the negroes of Africa. The shape of the skull varies much in some races;[17] and so it is with every other character. Now all naturalists have learnt by dearly bought experience how rash it is to attempt to define species by the aid of inconstant characters.

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independently in many cases, as far as we can judge, of their having intercrossed. Man has been studied more carefully than any other animal, and yet there is the greatest possible diversity amongst capable judges whether he should be classed as a single species or race, or as two (Virey), as three (Jacquinot), as four (Kant), five (Blumenbach), six (Buffon), seven (Hunter), eight (Agassiz), eleven (Pickering), fifteen (Bory de St. Vincent), sixteen (Desmoulins), twenty-two (Morton), sixty (Crawfurd), or as sixty-three, according to Burke.[18] This diversity of judgment does not prove that the races ought not to be ranked as species, but it shews that they graduate into each other, and that it is hardly possible to discover clear distinctive characters between them.

Every naturalist who has had the misfortune to undertake the description of a group of highly-varying organisms, has encountered cases (I speak after experience) precisely like that of man; and if of a cautious disposition, he will end by uniting all the forms which graduate into each other, under a single species; for he will say to himself that he has no right to give names to objects which he cannot define. Cases of this kind occur in the Order which includes man, namely in certain genera of monkeys; whilst in other genera, as in Cercopithecus, most of the species can be determined with certainty. In the American genus Cebus, the various forms are ranked by some naturalists as species, by others as mere geographical races. Now if numerous specimens of

[16] M. de Quatrefages has given (*Anthropological Review*, Jan. 1869, p. 22) an interesting account of the success and energy of the Paulistas in Brazil, who are a much crossed race of Portuguese and Indians, with a mixture of the blood of other races.

C w re collected from all parts f So th

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of man. Ne rth less, t m t be confessed that th re are f rms, t l ast n th getabl kingd m,[19] which we cann t oid naming as species, b t which are connected tog ther by umbe less gradati ns, ind pend ntly of in tercrossi g.

Som nat ralists ha latel empl yed th t rm sub- pecies to designate f rms whi h possess many f the charact ri tics f true spe cies, b t which hardl deserv so high a rank. N w if w reflect n th w ghty argum nts for raising th races f man to th

th t rm race w ll perhaps alwa be m-

d ne f the large gen g rally in lud closely allied f rms, which can be distin- guished nly w th m ch difficult whilst the smalle g n ra within th same family in lud forms that are perfectl dist nct y t all must be ranked eq ally as species. So again, pecies w thin th sam larg g us b no means re semble ach th to th same d gree n th contrar some of th m can g rally be ar ranged in little groups round th pecies, like sat ll tes ro d plan ts.[20]

Th q ti wh th mankind consists of one or se ral s cies has f late y ars been much discussed by anthropolo ts, wh are d led t th t schools f m nog nists and p l g ni ts. Those ho d not admit th principle of l t n, must look t pecies as separat creations, som mann as distinct tities and th must decid what forms of man they w ll consid as pecies by the anal gy of the m thod commonly p rsued anking othe rganic bei gs as peci s. B t t is h peless nd our t decid thi point, until som defin ti n of the term species is g n rall accepted and the definiti n must n t include an ind terminate element such as an act f creati n. We might as well tt mpt with t any d finition to decide wheth r a certain number of house should be called a ill ge town, o city W ha e a pract cal illustrati n f th difficulty in th n er-end ing d ubts wh th r many closely-all ed mam mals, birds, insects, and plants, wh ch repre sent ach othe respecti ly in North America and Europe h uld be ranked as pecies r geographical races and th like holds tru of the prod cti ns of many islands situated t som little distance from the nearest con t nt.

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our d mestic animals th qu tion wh th r the ari us races ha arisen from o e o m re specie is som what diff rent. Alth h t may be admitted th t all th races, as well as all the natural species within th sam gen s, ha prung from the same primiti tock, y t t is a fit subject f discussi n, wh th all th d mesti races of th d g, f nstance ha acquired th ir present am unt f diff nce since some pecies was first d mes- ticated by man wh th r th y owe som of their haracters to nheritance from distinct pecies, which had alread been diff rentiated in tate of nature W th man ch ques- can arise f h cann t b said to ha e been d m ticated t any particular period.

During an early tag n the di rg ce of th races of man from a common tock, th diff re ces between the races and th n m be must ha e been mall conseq ntly as far as th disti guishi g haract rs are co cerned th y th n had less laim to ank as dist nct peci than the existing so-called races. N rth less, so arb trary th t rm f pecies, that ch arly races w ld pe h p ha been ranked by some naturali ts as dis- tinct pecies, if their diff rences, alth gh trem ly sl ght, had been m re constant than th y are t present, and had n t gradu ted to ach th r

[19] Prof. Nägeli has carefully described several striking cases in his *Botanische Mittheil* gen, B n., 1866, ss. 294-369. Prof. Asa Gray has made analogous remarks some termediate forms in the Compositae of N. America.

[20] *Origin of Species*, this ed., p.

[21] See Prof. Huxley t this effect in the *Fortnightly Review*, 1865, p. 275.

single species. He will have been struck with the distribution of the several so-called races, which accords with that of other undoubtedly distinct species of mammals. Finally, he might urge that the mutual fertility of all the races has not as yet been fully proved, and even if proved would not be an absolute proof of their specific identity.

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Our naturalist would likewise be much disturbed as soon as he perceived that the distinctive characters of all the races were highly variable. This fact strikes every one on first beholding the negro slaves in Brazil, who have been imported from all parts of Africa. The same remark holds good with the Polynesians, and with many other races. It may be doubted whether any character can be named which is distinctive of a race and is constant. Savages, even within the limits of the same tribe, are not nearly so uniform in character, as has been often asserted. Hottentot women offer certain peculiarities, more strongly marked than those occurring in any other race, but these are known not to be of constant occurrence. In the several American tribes, colour and hairiness differ considerably; as does colour to a certain degree, and the shape of the features greatly, in the negroes of Africa. The shape of the skull varies much in some races;[11] and so it is with every other character. Now all naturalists have learnt by dearly bought experience how rash it is to attempt to define species by the aid of inconstant characters.

But the most weighty of all the arguments against treating the races of man as distinct species, is that they graduate into each other, independently in many cases, as far as we can judge, of their having intercrossed. Man has been studied more carefully than any other

as two (Virey), as three (Jacquinot), as four (Kant), five (Blumenbach), six (Buffon), seven (Hunter), eight (Agassiz), eleven (Pickering), fifteen (Bory de St Vincent), sixteen (Desmoulins), twenty-two (Morton), sixty (Crawfurd), or as sixty-three, according to Burke.[8] This diversity of judgment does not prove that the races ought not to be ranked as species, but it shews that they graduate into each other, and that it is hardly possible to discover clear distinctive characters between them.

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pp 198-209, 227 [illegible] *Physical Man*, Boston, 1866, p. 35

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arrow heads, bro ght from the most distant parts of the world, and manufactured t the most remote periods, are almost id ntical; and this fact can onl be accou ted f r by the arious races ha similar n nti o mental powers. Th sam observ ti has been mad by archæologists[26] with respect t certain wid l pre alent ornam ts, such as zig-zags, &c. and with respect t ari us simple belief and customs, ch as th burv g of th dead under megalithic structures. I rem mbe observin in So th America,[27] that there, as in so many oth parts of th w ld, m ha gen rall chosen the summits of loft hills, to throw p pil of to s, th r as record of som remarkabl e nt, f r burying their dead.

N w wh naturalists observ close agreement t um rous small d tails of hab ts, tastes, and d spositi between t o m re domestic races, between nearl allied natural forms, th use this fact as an argument that the are descended from comm n progenitor who was th nd ed and conseq entl that all sh ld be classed und th sam species. Th sam argum nt may be pplied w th much f rce to th race of man.

As t is mprobabl that th numerous and unimportant points of resemblance between the se ral races of man in bodily tru ture and m tal faculties I d not here ref t similar cu t ms should all ha bee independ tl acquired they must ha e been inh ri ed from pro enit rs who had these same haracters. W thus gain som insight int th arl stat of man, bef re h had pread p b step the face of th arth. Th spread g of man t regions wid l separated by the sea, no doubt, preceded an great am unt of di ence of haracte in th se ral races for otherwise w should som times meet with the sam race in distinct co tin ts and this ne the case. ir J. Lubbock, aft comparing the arts now practised by savages n all parts of the w rld, specifies those which man could n t ha e kn wn, wh n h first wand red from his original birthplace f r if once learnt th y would r h e been forg tten.[28] He thus sh w that the pear which is b t a d v l pment of the knife-point, and the lub which is but a l ng hamm are th nly thin s l ft." He admits, h w r that the art of making fire probably had been already disco ered, f t is comm n to all th races now existing, and was kn wn to th anci nt cave-inhab tants of Europe. P hap th art of making rud canoes o rafts was lik wise kn wn b t as man xisted at rem t poch, wh n the land in many place stood t ry diff rent le l to what t does n w h would ha been bl witho t th aid f canoes, to ha pread w d ly. Sir J. Lubbock further remarks h w improbabl t is that o earliest ancestors could ha counted as high as ten, consid ring that so many races w in xistence cann t get beyond f Ne rth l ss, at th arly period th int llectual and social faculties of man could hardly ha been inferi r in any e treme egree to th se possessed t present by th l we t sa ages otherwise prim al man could n t h e been so mi n ntl successful in th trug l f lif as pro ed by hi arl and wid diffus n.

From th fundam ntal d ff rence between certain languag s, som philol gists ha m f rred that wh n man fi t becam widely diffused, h was n t peaking animal b t it may be uspected that languages, far less perfect than an n w pok n, aided b tures, might ha been used and y t h v l ft no traces n subsequ nt and m re hi hly-d loped t gu s. W th t th use of som langua e, h w mperfect, it ppears d btful wh th man intellect could ha rise to th standard implied by his d minant positi n at an arl period.

Wh th prim al man, wh n h possessed b t f w arts, and th se f th rudest kind and when his pow f langu was trem ly imperfect, would h dese ed to be called man, mu t d pend n th d finit n which w m ploy. In series f f ms graduating insensibly from som pe l k cre t re t man as h n w xists, t w ll be mpossible to fix n any d finit point when th t rm man ght t be used. B t this is m tt of ry littl importance. So again, t is almost a matt of indiff rence wh th th so-called races of man

[26] O Analogous Forms of Implements, in Memoirs of Anthropological Society by H. M. Westropp. The Prim ve Inhabitants of Scand avia, E. g. tra lated by Sir J. Lubbock, 1868, p. 104.

[27] Westropp, On cromlechs, &c., Journal of Ethnological Soc., as gi Scientific Opinion, June 2, 1869, p. 3.

Journal of Researches: Voyage of the Beagle, p. 46.

[28] Prehistoric Times, 1869, p. 574.

It is however possible though far from probable that the early progenitors of man might formerly have diverged much in character until they became more unlike each other than any now existing races but that subsequently as suggested by Vogt[22] they converged in character When man selects the offspring of two distinct species for the same object he sometimes induces a considerable amount of convergence as far as general appearance is concerned This is the case as shown by von Nathusius[23] with the improved breeds of the pig which are descended from two distinct species and in a less marked manner with the improved breeds of cattle A great anatomist Gratiolet maintains that the anthropomorphous apes do not form a natural sub group but that the orang is a highly developed gibbon or Semnopithecus the chimpanzee a highly developed Macacus and the gorilla a highly developed mandrill If this conclusion which rests almost exclusively on brain characters be admitted we should have a case of convergence at least in external characters for the anthropomorphous apes are certainly more like each other in many points than they are to other apes All analogical resemblances as of a whale to a fish may indeed be said to be cases of convergence but this term has never been applied to superficial and adaptive resemblances It would however be extremely rash to attribute to convergence close similarity of character in many points of structure amongst the modified descendants of widely distinct beings The form of a crystal is determined solely by the molecular forces and it is not surprising that dissimilar substances should sometimes assume the same form but with organic beings we should bear in mind that the form of each depends on an infinity of complex relations namely on variations due to causes far too intricate to be followed —on the nature of the variations preserved these depending on the physical conditions and still more on the surrounding organisms which compete with each —and lastly on inheritance (in itself a fluctuating element) from innumerable progenitor all of which have had their forms determined through equally complex relations It appears incredible that the modified descendants of two organisms if these differed from each other in a marked manner should ever afterwards converge so closely as to lead to a near approach to identity throughout their whole organisation In the case of the convergent races of pigs above referred to evidence of their descent from two primitive stock is according to von Nathusius still plainly retained in certain bone of their skulls If the races of man had descended as is supposed by some naturalists from two or more species which differed from each other as much or nearly as much as does the orang from the gorilla it can hardly be doubted that marked differences in the structure of certain bones would still be discoverable in man as he now exists

Although the existing races of man differ in many respects as in colour hair shape of skull proportions of the body &c yet if their whole structure be taken into consideration they are found to resemble each other closely in a multitude of points Many of these are of so unimportant or of so singular a nature that it is extremely improbable that they should have been independently acquired by aboriginally distinct species or races The same remark holds good with equal or greater force with respect to the numerous points of mental

mind as any three races that can be named yet I was incessantly struck whilst living with the Fuegians on board the *Beagle* with the many little traits of character shewing how similar their minds were to ours and so it was with a full blooded negro with whom I happened once to be intimate

He who will read Mr Tylor s and Sir J Lubbock s interesting works[24] can hardly fail to be deeply impressed with the close similarity between the men of all races in tastes, dispositions and habits This is shown by the pleasure which they all take in dancing rude music acting painting tattooing and otherwise decorating themselves in their mutual comprehension of gesture language by the same expression in their features and by the same inarticulate cries when excited by the same emotions This similarity or rather identity is striking when contrasted with the different expressions and cries made by dis-

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[24] Tyl *E ly History f M nk nd*, 1865 with re pect t g ture-l gu g see s L bbock s *P histori T m* 2nd ed 1869

tinct species of m nkeys. Th re is good b rt f shooting with bows and

tropp and ... arrow h ads, brought from the most distant parts of th w ld, and man factured t the most rem t periods, are almost identical and this fact can nl be acco ted f r by the arious races ha g similar in nti or m tal pow rs. Th sam observ t has bee mad by archæologists* with respect to certain wid ly pre ale t rnam ts, uch as zig zags, &c. and with respect t ari us simpl beh f and cust ms, uch as th b ry in of th dead under megal thi stru t res. I rem mbe observin in So th Amer a,[27] that th re, as so many th parts f th w ld, m ha g rall chosen th ummits of loft hills, t throw p piles of t n s, th as record of som remarkabl t, or for burying their d ad.

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* O Analogous Forms of Impleme ts. M moi of Anthr pological Society by H. M. Westropp. The Primit ve Inh b t nt f S and navia, Eng. translat edited by ir J Lubbock, 1868, p. 104

Westropp On Cromlechs, &c., J urnal of Ethnological Soc as g in Scient fic Opi ion, June 2, 1869, p. 3.

[27] Journal of Re earches Voyage of the Beagle p. 46.

[28] P historic T mes, 1869 p. 5 4.

It is however possible though far from probable that the early progenitors of man might formerly have diverged much in character until they became more unlike each other than any now existing races but that subsequently as suggested by Vogt[22] they converged in character When man selects the offspring of two distinct species for the same object, he sometimes induces a considerable amount of convergence as far as general appearance is concerned This is the case as shown by von Nathusius[23] with the improved breeds of the pig which are descended from two distinct species and in a less marked manner with the improved breeds of cattle A great anatomist, Gratiolet maintains that the anthropomorphous apes do not form a natural sub group but that the orang is a highly developed gibbon or Semnopithecus the chimpanzee a highly developed Macacus and the gorilla a highly developed mandrill If this conclusion which rests almost exclusively on brain characters be admitted we should have a case of convergence at least in external characters for the anthropomorphous apes are certainly more like each other in many points than they are to other apes All analogical resemblances as of a whale to a fish may indeed be said to be cases of

... very rash to attribute to convergence ... ny points of ... cendants of ... a crystal is ... molecular forces and it is not surprising that dissimilar substances should sometimes assume the same form but with organic beings we should bear in mind that the form of each depends on an infinity of complex relations namely on variations due to causes far too intricate to be followed —on the nature of the variations preserved these depending on the physical conditions and still more on the surrounding organisms which compete with each —and lastly ... inherit ... from in... have had ... equally complex relations It appears incredible that the modified descendants of two organisms if these differed from each other in a marked manner should ever afterwards converge so closely as to lead to a near approach to identity throughout their whole organisation. In the case of the convergent races of pigs above referred to evidence of their descent from two primitive stocks is according to von Nathusius still plainly retained in certain bones of their skulls If the races of man had descended as is supposed by some naturalists from two or more species which differed from each other as much or nearly as much as does the orang from the gorilla it can hardly be doubted that marked differences in the structure of certain bones would still be discoverable in man as he now exists

Although the existing races of man differ in many respects as in colour hair shape of skull proportions of the body &c yet if their whole structure be taken into consideration they are found to resemble each other closely in a multitude of points Many of these are of so unimportant or of so singular a nature that it is extremely improbable that they should have been independently acquired by aboriginally distinct species or races The same remark holds good with equal or greater force with respect to the numerous points of mental similarity between the most distinct races of man The American aborigines Negroes and Europeans are as different from each other in mind as any three races that can be named yet I was incessantly struck whilst living with the Feugians on board the *Beagle* with the many little traits of character ... shewing how ... and so it was ... om I hap-

He who will read Mr Tylor's and Sir J Lubbock's interesting works[24] can hardly fail

... pleasure which they all take in dancing rude music acting painting tattooing and otherwise decorating themselves in their mutual comprehension of gesture language by the same expression in their features and by the same inarticulate cries when excited by the same emotions This similarity or rather identity is striking when contrasted with the different expressions and cries made by dis-

[22] ... [23] With respect to ... M ... Q atref g U ... de l Espece H ... ne 1861 p 119

[24] Tylor's Early History of Man ... 1865 with respect to ... gesture language see p ... Lubbock's ... to ... Tim... 2nd ed 1869

wh a weak tribe i not thus bruptly sw pt w y f it nce b gins to decrease, it g erally goes o decreas ng u til t becomes ext t.[37]

Wh civilised nati ns com into co tact with barbarians th truggl sh rt, except h re deadly l m te g it ai l t the nati race Of the se wl l l ad t the vict ry f ci lised t ns, som are plain and simple, th m complex and bscu W can see that th cult ti n f th land w ll be f tal in many way to sav g s, f th y can n t, will n t, change th h t ts. N w diseases and ha som ase pro ed highly destru ti and t ppears that n w disease fte cause m h d th, til those h are most scept bl t ts d t ti fl ce re grad lly weeded t[38] and so it m y b with th l ffects f m p rit us l q rs, as ll as with th unco q ably tr g tast f th m sh wn by so many sa ages. It furth ppears, my teri us as the fact that the first meeting f d tinct and sep rated peopl g t disease[39] M pr t wh in Vanco I lan l losel t te ded t th ubject f ti ti n, bel ed that changed hab ts f lif conseq t th ad t f Europeans, l ce m h ll h alth

th y l se th m t f rtu n, and get w th ir place.[40]

Th grad f th ci l sati seems to be a m t mpo tant l m t in th s ccess f com peti g t ns A f w ce tun g Europe feared th nroads f East rn barbarians w any ch f ar w uld be ridiculous. It is m re uri us fact, as M B h t has remarked that sa ages did n t f m ly wast w b f re th lassical t ns, as th y w d bef re mod rn lised nat ns had th y d so th ld m alist w ld ha mused th t b t th re is lam t in any write f that period th pe ishin barbarians.[36]

Th m t ret t f all th e uses f e tinct n,

be i jun us tl msel s. I am mu l in d bt d t Mr H H H w rth f r l all d ny attent to th is bject, and f r l ng g n nf m t re ect g it. H e col l cted th e f ll g ases.

Wh n Tasmani was f t colon s l the n t re n lly timated by some l 000 and by th rs at 20 000 Their n mber was soo g tl redu ed l fly by fight g w th the E gl h and w th ach th Aft r th f m us l t by all the col ts, wh the remai g nat s l l red th msel es p to th g rnm t, th y consi t d only of 120 d duals,[37] wh w re n 1832 tran ported to Flind rs I lan l This island sit ted between Tasmania and Australia, is f rty m l s l and from tw l t e ght en m le broad it seems h lthy and th nati es w w ll tre ted N rth less, th y ff ed gre tly n h alth. In 1834 th y consi ted (Bon ck, p 250) of f ty se n ad lt m les, forty-e ght adult f mal s, and ixteen hildren, or in all f 111 so ls. I 1835 ly ne hundred were left. As th y co ti ed rap dly t lecrease and as th y th msel es th ght th t th y sh ld t per h so quickly lse h re th y w re rem ed n 1847 to Oy t r Co e in the so thern part f Tasmania. Th y th n con ted (Dec. 0th, 184) of f urteen m n, tw nty tw w m n and t n l l lren[38] But th chan f sit did n good D sease and d th till p rsued th m, and n 1864 ne man (wh d ed n 1869) and th ee ld ly w m lo e ur ed Th nf rtility f the w m s n a m remarkable fact than th liab l ty f all to ill h alth and death. At th tim wh nly ni e w men w l ft Oy te Co th y told Mr Bo w ck (p 386) th t nly tw had borne hildre and these t had tog ther produced nly three child

W th re pect to the se f th trao dinary tat f th gs, D tory r marks th t d th f ll wed th att mpts to ci l se th n ti es. If l ft t th msel l roam as th y w re t and d turbed th y w uld h e

[35]Gerland ibid. s. 12, gi es f cts pport f this

ne be se p 435) good ma y cases bearing this subject see also Gerla d, ibid. S. Poepp g speaks f the breath of ci ilisatio as poiso us to sa es

[39]Sproat, Scene nd Studies f S vag L f 1868 p. 284

Bageh t, Phy m d P litics, Fort ghtly Re iew April 1, 1868, p 455

[37] L, p 67

are thus designated or are ranked as species or sub species but the latter term appears the more appropriate Finally we may conclude that when the principle of evolution is generally accepted as it surely will be before long the dispute between the monogenists and the polygenists will die a silent and unobserved death

One other question ought not to be passed over without notice namely whether as is sometimes assumed each sub species or race of man has sprung from a single pair of progenitors With our domestic animals a new race can readily be formed by carefully matching the varying offspring from a single pair or even from a single individual possessing some new character but most of our races have been formed not intentionally from a selected pair but unconsciously by the preservation of many individuals which have varied however slightly in some useful or desired manner If in one country stronger and heavier horses and in another country lighter and fleeter ones were habitually preferred we may feel sure that two distinct sub breeds would be produced in the course of time without any one pair having been separated and bred from in either country Many races have been thus formed and their manner of formation is closely analogous to that of natural species We know also that the horses taken to the Falkland Islands have during successive generations become smaller and weaker whilst those which have run wild on the Pampas have acquired larger and coarser heads and such changes are manifestly due not to any one pair but to all the individuals having been subjected to the same conditions aided perhaps by the principle of reversion The new sub breeds in such cases are not descended from any single pair but from many individuals which have varied in different degrees but in the same general manner and we may conclude that the races of man have been *similarly* produced the modifications being either the direct result of exposure to different conditions or the indirect result of some form of selection But to this latter subject we shall presently return

On the Extinction of the Races of Man —The partial or complete extinction of many races and sub races of man is historically known Humboldt saw in South America a parrot which was the sole living creature that could speak a word of the language of a lost tribe. Ancient monuments and stone implements found in all parts of the world about which no tradition has been preserved by the present inhabitants *indicate much extinction* Some small and broken tribes, remnants of former races still survive in isolated and generally mountainous districts In Europe the ancient races were all according to Shaaffhausen,[5] *lower in the scale than the rudest living savage* they must therefore have differed to a certain extent from any existing race The remains described by Professor Broca from Les Eyzies though they unfortunately appear to have belonged to *a single family* indicate a race with a most singular combination of low or simious and of high characteristics. This race is entirely different from any other ancient or modern that we have heard of [6] It differed therefore from the quaternary race of the caverns of Belgium

Man can long resist conditions which appear extremely unfavourable for his existence [7] He has long lived in the extreme regions of the North with no wood for his canoes or implements and with only blubber as fuel

[illegible]

worthy to be called a hovel In South Africa the aborigines wander over arid plains where dangerous beasts abound Man can withstand the deadly influence of the Terai at the foot of the Himalaya, and the pestilential shores of tropical Africa

Extinction follows chiefly from the competi

[illegible]

especially lessened fertility If any one of these checks increases in power even slightly the tribe thus affected tends to decrease and when of two adjoining tribes one becomes less numerous and less powerful than the other the contest is soon settled by war slaughter cannibalism slavery and absorption Even

[5] Translation in *Anthropological Review* Oct. 1868, p. 431

[illegible]

Dr Gerland *Über das Aussterben* [illegible] 1868 s. 82.

Year	Native Population (Except durn 1832 and 1836, hen the few foreigners in the islands were included.)	Annual rate of decrease per cent, according to have been ... between the successive censuses; these censuses being taken at irregular intervals.
1832	130,313	
		4 46
1836	108,579	
		2 4
1853	1 019	
		0 81
1860	67 084	
		2 18
1866	58, 65	
		2 17
1872	51,531	

W h re see that th t rval of f rty

q red tribe and to n wly introduced diseases, which ha been se ral occas nse trem ly destructi e. No d bt these and th ch ca ses h been lughl ffi nt, and may account f th xtraordinary rat of decrease betwe th years 183 and 1836 b t the mo t pot t of all th cause seem t be lesse ed f rtility According t Dr Rusch n berr of th U. S. N vy wh isited these sland betwee 1835 and 183 in dis-trict of Hawaii, nl tw t fi m out of 1134 and in anoth distri t nly t n o t of 637 had famil with as man as three children. Of eight married w m n, nly thirt m had born children and th fficial report g es an rag f half child to each married co pl in th wh l sland. This almost xactly th sam rage as with th Tasmanians t O t Co Jarves, who p b shed his *Hist ry* in 1843 sa that families who have three children are freed from all taxes those ha in more are re warded b gifts f land and th nco rage-m ts. This parall led nactm t by th g rnm t w ll sh w h w *inf rtil* th race had becom Th R A. B sh p tated th Hawaiian *Spectat* in 1839 th t larg pro-porti of th hildre di at arly ges, and Bishop Stale inf rms m that this is still th case j st as in N w Zealand Thi has bee ttrib ted t th n glect f th childre b th w m n, b t t is probably large part d t

innate w akness of const tuti n n the chil dren, relat t th l ssened f rt l ty of th parents. Th re is, moreo r a furth r resemblance to th case of New Zealand in th fact that th re is a large xcess of male r f mal births th census of 1872 g es 31 650 males t 25 f males f all ages, that is 125.36 males f r ry 100 females wh reas n all ci l sed co tries the f males xceed the males. N d bt th profligacy of th w m n m y n part acco t f r th mall f rtilit b t th hanged hab ts of lif is much more probable cause and which w ll at the same tim acco t f the increased mortalit es-peciall of th children. The island w re isited b Cook 1779 by Vancou r 1 94 and oft n bseq tl by whalers. In 1819 missi nari arri ed, and f nd that id latry had been alread aboli hed and oth r hang s ffected b the ki g. Aft r this period there was rapid hang n almo t all th hab t of lif of th nat s, and th y soo becam th most ci l sed of th Pacific I land rs. On of my nformants, Mr Coan, wh o was born th islands, remarks that th nati es h un d rg great hange i th ir hab ts of life in th co rse of fift ears than Englishm n d n a tho sand y ars. From i f rmation rece ed from Bish p Stal y t doe not ppear that th poore lasse ha r m h changed th d t, altho gh many ew kinds of fru t ha e bee troduced, and th gar-cane is in uni rsal use O g h w t th i passi n f imitat g E ropeans, th alt red th r man of dress g t an arly period, and th use of alcoholic drinks becam ry g n ral. Alth gh these hange ppear consid able I can w ll bel from what is kn wn with re pect to an mals, that th y m ght ffice t lesse the f rtil t of th nati es.[a]

Lastl M Macnamara t t " th t th l w and d graded inhab tants of th Andaman Islands, n th ast rn id of the Gulf of Ben gal, are min ntly uscept bl t an hange

[a] The f regoi g stat me t are take hiefly from the f llo g w rks J rv *History of the H wa in Isl nds* 1843, pp. 400-407 Cheever *Li in the Sandw h Islands*, 1851 p. 277 Rusche berger is quoted B Bo ick, *Last f the Tasm ians* 18 0 p. 3 8. Bishop is quoted by Sir E. Belch *Voyag Ro nd th World*, 1843, ol i., p. 272. I w the census of the several years t the ki dness of M Coan, t the re-quest of D Y umans of New York d most cases I ha e compared the Y umans figures th those gi e se eral of the bo e-named works. I ha mitted the census for 1850 as I ha e see tw idel differe t umbers gi n.

[a] *The Indian Medical Gazette* N 1 1871 p. 240.

reared more children and there would have been less mortality Another careful observer of the natives Mr Davis remarks The births have been few and the deaths numerous This may have been in a great measure owing to their change of living and food but more so to their banishment from the mainland of Van Diemen s Land and consequent depression of spirits (Bonwick pp 388 390)

Similar facts have been observed in two widely different parts of Australia The celebrated explorer Mr Gregory told Mr Bonwick that in Queensland the want of reproduction was being already felt with the blacks even in the most recently settled parts and that decay would set in Of thirteen aborigines from Shark s Bay who visited Murchison River twelve died of consumption within three months [38]

The decrease of the Maories of New Zealand has been carefully investigated by Mr Fenton in an admirable report from which all the following statements with one exception are taken [40] The decrease in number since 1830 is admitted by every one, including the natives themselves and is still steadily progressing Although it has hitherto been found impossible to take an actual census of the natives their numbers were carefully estimated by residents in many districts The result seems trustworthy and shows that during the fourteen years previous to 18 8 the decrease was 19 42 per cent Some of the tribes thus carefully examined lived above a hundred miles apart some on the coast some inland and their means of sul

, at another census was taken and the number is given as only 36 3 9 shewing a decrease of 3 9) per cent [1] Mr Fenton after shewing in detail the insufficiency of the various cause usually assigned in explanation of this extraordinary decrease such as new diseases the profl ars de pend the women and on the extraordinary mortality of the young children (pp 31 34) In proof of this he shews (p 33) that in 1844 there was one non adult for every 2 57 adults whereas in 1858 there was only one non adult for every 3 27 adults The mortality of the adults is also great He adduces as a further cause of the decrease the inequality of the sexes for fewer females are born than males To this latter point depending perhaps on a widely distinct cause I shall return in a future chapter Mr Fenton contrasts with astonishment the decrease in New Zealand with the increase in Ireland countries not very dissimilar in climate and where the inhabitants now follow nearly similar habits The Maories themselves (p 35) attribute their decadence in some measure to the introduction of new food and clothing and the attendant change of habits and it will be seen when we consider the influence of changed conditions on fertility that they are probably right The diminution began between the years 1830 and 1840 and Mr Fenton shews (p 40) that about 1830 the art of manufacturing putrid corn (maize) by long steeping in water was discovered and largely practised and this proves that a change of habits was beginning among the natives even when New Zealand was only thinly inhabited by Europeans When I visited the Bay of Islands in 183 the dress and food of the inhabitants had already been much modified they raised potatoes maize and other agricultural produce and exchanged them for English manufactured goods and tobacco

It is evident from many statements in the life of Bishop Patteson [2] that the Melanesians of the New Hebrides and neighbouring archipelagoes suffered to an extraordinary degree in health and perished in large numbers when they were removed to New Zealand Norfolk Island and other salubrious places in order to be educated as missionaries

The decrease of the native population of the Sandwich Islands is as notorious as that of New Zealand It has been roughly estimated by those best capable of judging that when Cook discovered the island in 1 the population amounted to about 300 000 According to a loose census in 18 the numbers then were 14 050 In 183 and at several subsequent periods an accurate census was officially taken but I have been able to obtain only the following returns

[1] New Z l nd by Alex K dy 18 3 p 47

[2] L f f J C P tteso by C M Young 18 4 see m re e p c lly L i p 530

not quite free in their native country, are rendered sterile; and others thus circumstanced frequently breed, but never produce offspring; others again produce some offspring, but fewer than in a state of nature; and as bearing on the above cases of man, it is important to remark that the young are apt to be weak and sickly, or malformed, and to perish at an early age.

Seeing how general is this law of the susceptibility of the reproductive system to changed conditions of life, and that it holds good with our nearest allies, the Quadrumana, I can hardly doubt that it applies to man in his primeval state. Hence if savages of any race are induced suddenly to change their habits of life, they become more or less sterile, and their young offspring suffer in health, in the same manner and from the same cause, as do the elephant and hunting-leopard in India, many monkeys in America, and a host of animals of all kinds, on removal from their natural conditions.

We can see why it is that aborigines, who have long inhabited islands, and who must have been long exposed to nearly uniform conditions, should be specially affected by any change in their habits, as seems to be the case. Civilised races can certainly resist changes of all kinds far better than savages; and in this respect they resemble domesticated animals, for though the latter sometimes suffer in health (for instance European dogs in India), yet they are rarely rendered sterile, though a few such instances have been recorded. The immunity of civilised races and domesticated animals is probably due to their having been subjected to a greater extent, and therefore having grown somewhat more accustomed, to diversified or varying conditions, than the majority of wild animals; and to their having formerly immigrated or been carried from country to country, and to different families or sub-races having inter-crossed. It appears that a cross with civilised races at once gives to an aboriginal race an immunity from the evil consequences of changed conditions. Thus the crossed offspring from the Tahitians and English, when settled in Pitcairn Island, increased so rapidly that the island was soon overstocked; and in June 1856 they were removed to Norfolk Island. They then consisted of 60 married persons and 134 children, making a total of 194. Here they likewise increased so rapidly, that although sixteen of them returned to Pitcairn Island in 1859, they numbered in January 1868, 300 souls; the males and females being in exactly equal numbers. What a contrast does this case present with that of the Tasmanians; the Norfolk Islanders increased in only twelve and a half years from 194 to 300; whereas the Tasmanians decreased during fifteen years from 120 to 46, of which latter number only ten were children.*

So again in the interval between the census of 1858 and 1872 the natives of full blood in the Sandwich Islands decreased by 8081, whilst the half-castes, who are believed to be healthier, increased by 847; but I do not know whether the latter numbers include the offspring from the half-castes, or only the half-castes of the first generation.

The cases which I have here given and reviewed [illegible] natives who have been subjected to [illegible]

[illegible] pelled by any cause, such as the inroad of a conquering tribe, to desert their homes and to change their habits. It is an interesting circumstance that the chief check to wild animals becoming domesticated, which implies the power of their breeding freely when first captured, and one chief check to wild men, when brought into contact with civilisation, surviving to form a civilised race, is the same, namely, sterility from changed conditions of life.

Finally, although the gradual decrease and ultimate extinction of the races of man is a highly complex problem, depending on many causes which differ in different places and at different times; it is the same problem as that presented by the extinction of one of the higher animals—of the fossil horse, for instance, which disappeared from South America, soon afterwards to be replaced, within the same districts, by countless troops of the Spanish horse. The New Zealander seems conscious of this parallelism, for he compares his future fate with that of the native rat now almost exterminated by the European rat. Though the difficulty is great to our imagination, and really great if we wish to ascertain the precise causes and their manner of action, it ought not to be so to our reason, as long as we keep steadily in mind that the increase of

Variation of Animals, &c. vol. ii. p. 16.

* These details are taken from *The Mutineers of the Bounty*, by Lady Belcher, 1870; and from *Pitcairn Island*, ordered to be printed by the House of Commons, May 29th, 1863. The following statements about the Sandwich Islanders are from the *Honolulu Gazette* and from Mr. Coan.

of climate in fact take them away from their island homes and they are almost certain to die and that independently of diet or extraneous influences He further states that the inhabitants of the Valley of Nepal which is extremely hot in summer and also the various hill tribes of India suffer from dysentery and fever when on the plains and they die if they attempt to pass the whole year there.

We thus see that many of the wilder races of man are apt to suffer much in health when subjected to changed conditions or habits of life and not exclusively from being transported to a new climate Mere alterations in habits which do not appear injurious in themselves seem to have this same effect and in several cases the children are particularly liable to suffer It has often been said as Mr Macnamara remarks that man can resist with impunity the greatest diversities of climate and other changes but this is true only of the civilised races Man in his wild condition seems to be in this respect almost as susceptible as his nearest allies the anthropoid apes, which have never yet survived long when removed from their native country

Lessened fertility from changed conditions, as in the case of the Tasmanians ... s s- ir a e ... use of every population would sooner or later lead to extinction The diminution of fertility may be explained in some cases by the profligacy of the women (as until lately with the Tahitians) but Mr Fenton has shewn that this explanation by no means suffices with the New Zealanders nor does it with the Tasmanians

In the paper above quoted Mr Macnamara gives reasons for believing that the inhabitants of districts subject to malaria are apt to be sterile but this cannot apply in several of the above cases Some writers have suggested that the aborigines of islands have suffered in fertility and health from long continued interbreeding but in the above cases infertility has coincided too closely with the arrival of Europeans for us to admit this explanation Nor have we at present any reason to believe that man is highly sensitive to the evil effects of interbreeding especially in areas so large as New Zealand and the Sandwich archipelago with its diversified stations. On the contrary it is known that the present inhabitants of Norfolk Island are nearly all cousins or near relations, as are the Todas in India, and the inhabitants of some of the Western Islands of Scotland and yet they seem not to have suffered in fertility.[48]

A much more probable view is suggested by the analogy of the lower animals The reproductive system can be shewn to be susceptible to an extraordinary degree (though why we know not) to changed conditions of life and this susceptibility leads both to beneficial and to evil results. A large collection of facts on this subject is given in chap. xviii of vol. ii of my *Variation of Animals and Plants under Domestication* ... can here give only the brief abstract and every one interested in the subject may consult the above work Very slight changes increase the health vigour and fertility of most or all organic beings, whilst other changes are known to render a large number of animals sterile One of the most familiar cases is that of tamed elephants not breeding in India though they often breed in Ava, where the females are allowed to roam about the forests to some extent, and are thus placed under more natural conditions. The case of various American monkeys both sexes of which have been kept for many years together in their own countries, and yet have very rarely or never bred is a more apposite instance because of their relationship to man It is remarkable how slight a change in the conditions often induces sterility in a wild animal when captured and this is the more strange as all our domesticated animals have become more fertile than they were in a state of nature and some of them can resist the most unnatural conditions with undiminished fertility.[49] Certain groups of animals are much more liable than others to be affected by captivity and generally all the species of the same group are affected in the same manner But sometimes a single species in a group is rendered sterile whilst the others are not so on the other hand a single species may retain its fertility whilst most of the others fail to breed The males and females of some species when confined or when allowed to live almost, but ...

48 ... Norfolk Island ...

... *... male* &c. vol. ... p. 111

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alm t t m nated by th E ropean t
Tl gh th d fficulty s gr t to im gi
ti n, and really re t, if w wish to asc ta n
th prec se se and th man of act on,
I ght n t t b so to r r aso as l g as
l p t adily in mi d th t the in ase f

l rnal on f A mal d L i., p. 16

[49] These d ta ls are take f m Th Mut neer f the Bo ty by Lady B l her 18 0 d from Pitcairn Island rd red t b pri ted by th H use f C mm ns, M y 29 1863 Th f ll g tatem t bo t th S d ch Isla der re from th H nolul Gazette d f m M C an.

each species and each race is constantly checked in various ways so that if any new check even a slight one be superadded the race will surely decrease in number and decreasing numbers will sooner or later lead to extinction the end in most cases being promptly determined by the inroads of conquering tribes

On the Formation of the Races of Man —In some cases the crossing of distinct races has led to the formation of a new race The singular fact that the Europeans and Hindoos who belong to the same Aryan stock and speak a language fundamentally the same differ widely in appearance whilst Europeans differ but little from Jews who belong to the Semitic stock and speak quite another language has been accounted for by Broca [49] through certain Aryan branches having been largely crossed by indigenous tribes during their wide diffusion When two races in close contact cross the first result is a heterogeneous mix

from the black squat tribes of the mountains to the tall olive coloured Brahman with his intellectual brow calm eyes and high but narrow head so that it is necessary in courts of justice to ask the witnesses whether they are Santalis or Hindoos [50] Whether a heterogeneous people such as the inhabitants of some of the Polynesian islands formed by the crossing of two distinct races with few or no pure members left would ever become homogeneous is not known from direct evidence But as with our domesticated animals a cross breed can certainly be fixed and made uniform by careful selection[51] in the course of a few generations we may infer that the free inter crossing of a heterogeneous mixture during a long descent would supply the place of selection and overcome any tendency to reversion so that the crossed race would ultimately become homogeneous though it might not partake in an equal degree of the characters of the two parent races

Of all the differences between the races of man the colour of the skin is the most conspicuous and one of the best marked It was formerly thought that differences of this kind could be accounted for by long exposure to different climates but Pallas first shewed that this is not tenable and he has since been followed by almost all anthropologists [52] This view has been rejected chiefly because the distribution of the variously coloured races, most of whom have long inhabited their present homes does not coincide with corresponding differences of climate Some little weight may be given to such cases as that of the Dutch families who as we hear on excellent authority [53] have not undergone the least change of colour after residing for three centuries in South Africa An argument on the same side may likewise be drawn from the uniform appearance in various parts of the world of gipsies and Jews though the uniformity of the latter has been somewhat exaggerated [54] A very damp or a very dry atmosphere has been supposed to be more influential in modifying the colour of the skin than mere heat but as D Orbigny in South America and Livingstone in Africa arrived at diametrically opposite conclusions with respect to dampness and dryness any conclusion on this head must be considered as very doubtful [55]

Various facts which I have given elsewhere prove that the colour of the skin and hair is sometimes correlated in a surprising manner with a complete immunity from the action of certain vegetable poisons and from the attacks of certain parasites Hence it occurred to me that negroes and other dark races might have acquired their dark tints by the darker individuals escaping from the deadly influence of the miasma of their native countries during a long series of generations

I afterwards found that this same idea had long ago occurred to Dr Wells [56] It has long been known that negroes and even mulattoes, are almost completely exempt from the yellow

[49] On Anthropology tr nslat o Anth opol g ical Rev w Jan 1868 p 38

[50] Tl t im I f R al Bengal, 1868 p 134

[51] The V ri t n f A mals and Pl nts und Domestication, v l ii p [illegible]

p

th d i c g e by God De l'Espèce 1859 v l i p 246 &

[53] Sir A d w Smith as qu t d by K ox Rac s f M 1850 p 473

[54] See D Qu tr f g th s l d Revu de Co rs Sci nt fiqu Oct. 17 1868 p 731

[55] Livingston T l d R he S Africa 1857 pp 338 339 D Orb [illegible] y quoted by Godro

col [illegible] ted w th co t t t al pecul t s re g y I t f t mal nd Pl nt u der Dom tical l i p 22 33

destruct [illegible] in tropical America.[s] [illegible] ured with but little success,[u] to ascer

and su [illegible]

manner When he first arrived as a boy in the [illegible] perienced a gro [illegible] pre-

and peculiar

the result of acclimatisation I [illegible] t t s that the negro regiments recruited near the Soudan, and borrowed from the Viceroy of Egypt for the Mexican war escaped the yellow fever almost equally with the negroes originally brought from various parts of Africa and accustomed to the climate of the West Indies That acclimatisation plays [illegible] part, is shown by the many cases in which negroes have become somewhat liable to tropical

the death rate of the immigrants was proportional to the latitude of the country whence they had come. With the negro [illegible] immunity as far as it is the result of acclimatisation, implies exposure during a prolonged length of time of the aborigines of tropical America [illegible] has resided there from time immemorial are not exempt from yellow fever and the Rev. H. B. Tristram states that in the northern districts of northern Africa [illegible] the inhabitants are compelled annually to [illegible] though the negroes can remain with safety That the immunity of the negro is in any degree correlated with the colour of his skin is a mere conjecture it may be correlated with some difference in his blood [illegible] system, [illegible] Nevertheless, from the facts above alluded to and from some connection apparently existing between complexion and tendency to consumption the conjecture seemed to me not improbable Consequently I

[illegible]

In the spring of 1862 I obtained permission from the Director-General of the Medical department of the Army to transmit to the surgeons of the various regiments on foreign service blank tables with the following appended remarks, but I have received no returns [illegible] several well marked cases have been recorded with our domestic animals of a relation between the colour of the dermal appendages and the constitution and it being notorious that there is some limited degree of relation between the colour of the races of man and the climate inhabited by them the following investigation seems worth consideration Namely, whether there is any relation in Europeans between the colour of their hair and their liability to the diseases of tropical countries. If the surgeons of the several regiments, when stationed in unhealthy tropical districts, would be so good as first to count, as a standard of comparison, how many men in the force whence the sick are drawn [illegible]

[illegible] some thousand cases had been tabulated [illegible] the

[illegible] habit [illegible] from a remote period [illegible] healthy tropical climate might have become dark-coloured by the better [illegible] of dark-haired [illegible] complexioned individuals during a long succession of

[illegible] from disease of tropical countries that persons with dark hair and sallow complexions and so far as I know other p-

See for instance Nott and Gliddon *Types of Mankind* p 68

Major Tulloch in a paper read before the Statistical Society April 20 1840 and given in the *Athenæum* 1840 p 353

The Plurality of the Human Race (translat.) 1864 p 60

[u]Quatrefages, *Unité de l'Espèce Humaine* 1861 p 205 Waitz, *Introduct to Anthropology* translat. Vol. i, 1863 p 124 Livingstone gives analogous cases in his *Travels*

fore as these slight indications go there seems no foundation for the hypothesis that blackness has resulted from the darker and darker individuals having survived better during long exposure to fever generating miasma

Dr Sharpe remarks[illegible] that a tropical sun which burns and blisters a white skin does not injure a black one at all and as he adds this is not due to habit in the individual for children *only six or eight months old are often* carried about naked and are not affected I have been assured by a medical man that some years ago during each summer but not during the winter his hands became marked with light brown patches like although larger than freckles and that these patches were never affected by sun burning whilst the white parts of his skin have on several occasions been *much inflamed and blistered With the lower* animals there is also a constitutional difference in liability to the action of the sun between those parts of the skin clothed with white hair and other parts[45] Whether the saving of the skin from being thus burnt is of sufficient importance to account for a dark tint having been gradually acquired by man through natural selection I am unable to judge If it be so we *should have to assume that the natives of tropi*cal America have lived there for a much shorter time than the Negroes in Africa or the Papuans in the southern parts of the Malay archipelago just as the lighter coloured Hindoos have resided in India for a shorter time than the darker aborigines of the central and southern parts of the peninsula

Although with our present knowledge we cannot account for the differences of colour in the races of man through any advantage thus gained or from the direct action of climate

We have seen in the second chapter that the conditions of life affect the development of the bodily frame in a direct manner and that the effects are transmitted Thus as is generally admitted the European settlers in the United States undergo a slight but extraordinary rapid change of appearance Their bodies and limbs become elongated and I hear from Col Bernys that during the late war in the United States, *good evidence was afforded of this fact by the* ridiculous appearance presented by the German regiments when dressed in ready made clothes manufactured for the American market and which were much too long for the men in every way There is, also a considerable body of evidence shewing that in the Southern States the house slaves of the third generation present a markedly different appearance from *the field slaves*[46]

If however we look to the races of man as distributed over the world we must infer that their characteristic differences cannot be accounted for by the direct action of different conditions of life even after exposure to them for an enormous period of time The Esquimaux live exclusively on animal food they are clothed in thick fur and are exposed to intense *cold and to prolonged darkness yet they do* not differ in any extreme degree from the inhabitants of southern China who live entirely on vegetable food and are exposed almost naked to a hot glaring climate The unclothed Fuegians live on the marine productions of their inhospitable shores the Botocudos of Brazil wander about the hot forests of the interior and live chiefly on vegetable productions yet these tribes resemble each other so closely that the Fuegians on board the Beagle were mistaken by some Brazilians for Botocudos. The Botocudos again as well as the other inhabitants of tropical America are wholly different from the Negroes who inhabit the opposite shores of the Atlantic are exposed to a nearly similar climate and follow nearly the same habits of life

Nor can the differences between the races of man be accounted for by the inherited effects of the increased or decreased use of parts except to a quite insignificant degree Men who habitually live in canoes, may have their legs

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[illegible] g us cas [illegible] Dr Rolle (*Der M[illegible]nsch* [illegible]) [illegible] &c. 186[illegible] s. 99) st[illegible]t[illegible] n the [illegible] th[illegible]r[illegible]ty [illegible] Khan[illegible] that th[illegible] great[illegible] numb[illegible]r [illegible] C[illegible]rm[illegible] f[illegible]m[illegible]ilies settled in Geo[illegible] [illegible] *acq[illegible]red [illegible] th[illegible] cours[illegible]*

ted th se wh hab t l ftv are t ce m t by the l jects n tf at ben fcial

anat ns l n an be thu prese rd and as far as we re bled to j d ltl h always l rr thi head none f tl e l ffer

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som conseq tly littl mod fed With ct u h red ced f th j w f m l s- r

n t b f m cl impo tance f t mpo a tl j w ld l ng ag l been tl r f ed d preserved o l minated In th s re pect u an resembles tl se f rr s, alled by n t ralists prot an poly rpl c, wl cl h re at ed tre n ly ari l l o g as t see s, t s cl vari t ns be f an indiff rent n t re and to the h g tl us sc ped tl e acti n f n t al selecti

W l e th s far bee baffled in all our ttemp ts t acco t f tl d ffe nce bet en th race f man b t there remain o e impor tant ag ncy nam ly Se u l Select n, wl ch ppears t l acted po rf lly n man, as o n any tl anim ls. I d n t i t nd to rt th t se u l select n w ll acco t f r ll

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lttl ro d r arrow r and w tl n se n littl l g o h rt su b l gl t d ff re ce m gl t becom fi ed and u if rm, f tl u kn wn cies wl cl i l ced tl m w re to act m re co t t m n aided by l co t n ed i terero ng S l ari t come nd tl p o n al lass, ll ded to n r

d dual diff re ce t wh ch m ma tl habl m y t h bee preserved and gm ted d ing l g sen f g e a- t ns th gh nat al selecti n. H t h re we

fact if man h d n t bee modified by th ag cy wh h ppe rs to l acted pow r fully n mn m abl an ma-s It n furth be h wn th t tl d ff rence b tw the races f man as in col hairi as, f m f f tur s, & f k l wl h ght l bee pected t com u d th nce f se l sel t B t rd to t t this bject p p ly I h f d t necessary t pas th wh l animal kingd m n w I th f red tedt t th Second Part f thi w k At th l I sh ll t rn to man, and afte tt mpt g to l h w f h l as been modified thro gh al select w ll

See Prof Sch affh us n, tr slat. in *Anthropological Review* Oct. 1868 p 429

M C th tates (N *America Indians* 3rd

coarse and h h as th t f h rse ma hilst th h f th colours fi nd ft.

O th od ur of th k *Godr n, D FE per* t m. p 217 O th po es f the kin, D Wil k ns, *Die A fgaben der Landwirth Zool ch k* 1869 7

fore as these slight indications go there seems no foundation for the hypothesis that blackness has resulted from the darker and darker individuals having survived better during long exposure to fever generating miasma

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Although with our present knowledge we cannot account for the differences of colour in the races of man through any advantage thus gained or from the direct action of climate yet we must not quite ignore the latter agency for there is good reason to believe that some inherited effect is thus produced [65]

We have seen in the second chapter that the conditions of life affect the development of the bodily frame in a direct manner and that the

change of appearance Their bodies and limbs become elongated and I hear from Col Bernys

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p r to be good gr nds f this m k On the
Mr Hed Leone ho has

[66] ... Med ... p. 532 Quatrefages (Unité de l'Espèce Humaine 1861 p 128) has collected much evidence on this head

I ... rst ro ect g co ol t nd
I

presence of the pe ...
inclined t think that t has sted in ne hemisphere t least, majority of the br ns of this animal whi h ha p t this tim bee figured or described. The perfi ial pos t of the second bridging co l t is d tly less freque t nd has as t, I belie nly bee see in the brai (4) recorded in this comm nicat n. The asymm trical arra em t in the co ol ti ns of the tw hemispheres, hich prev us bserv rs ha ref rred t in their de-cript ons, is also w ll illustrated these specim ns (pp. 8, 9)

E were the presence of the t mporo-occipital, or xternal perpendicular ulcus, mark of distinctio bet een the higher pes nd m n, the alue of such distincti charact uld be rendered very d btful by the tructure f the brai the platy hine pes. In fact, whil the t mporo-occipit l ne of th most consta t of ulci in the catarhine Old World, pes, t is er ery tro gly d loped in the N w W ld pes t is bse t th malle platy hine rudime tary in f thecia d more less ol literated b bridging co l ti ns in At les. A haracter which is thus ariabl th th limits of single group can ha no great tax nomic value

It is further established, that th d gree of a ym metry of the co l t of th t ides the huma brai is ubject t much nd idual ari tio and that, in those indi iduals of th bushman race who ha e bee exami ed the gyri nd ulci of the t ll mispheres are consid rably less complicated and more ymm trical than the Europe brain, hile som ndi iduals of th ch mpanzee, th ir complexity and asymmetry becom notable This is particularly th case th brain of ung male chimpanzee figured by M Broca. (*L ord de Primates*, p 16 fig 11)

Again, as respects th q est of bsol t size t is est blished that th differe ce bet ee th largest nd th smallest heal hy huma bra is great tha th difference bet ee th mallest healthy *human brain nd th largest chimpanzee* ra g brain.

Moreo er there is circum ta ce in hich th orang nd chimpanzee brains resemble m s, but h h they differ from th lo er pes, d that th presence of t corpora candica tia—th Cynom rpha having b t ne

I view of these fact I d not hesitat in this y ar l 4 t repeat nd insist po the propositio hich I unciated in 1863

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panzee nd of ma lm st ns g compared th that bet ee th himpanzee b in nd that of lemur

I the p pe t hich I ha e ref rred, I rofesso Bischoff does ot d y th second part of this t tem t, b t he first makes th irrele t remark that t is t nd rf l if th b ns of ora g nd lemur are ery differe t nd secondly goes t assert that, *If* *ucce* *ly compare* th b ain of ma th that of ra g th bra of this th that of himpanzee of this th that of gorilla, nd so of Hylobat s, Sem iop thecus, C nocephalus, Cercopithecus, M cacus, C bus, C llithrix, Lemur t nops, Hapale shall not meet th gre t as gre t bre k the d gree of d l pm t of th co ol t s, as find bet ee th brai of man nd that of an rang h mpanzee

T hich I reply firstly that heth this assertio be true or f lse t has no thi g hat t d th the propositio nciated in *M I lace* N t ll h ref rs t t the d lopme t of the co l tions alone b t t the tructure of tl hole brain. *If Prof sso Bischoff had tak th trouble t* refer t p. 96 of the ork h criticises, fact, he would have f nd the follo g passage "And t remarkable circumst nce that th ugh, so far as ur prese t kno ledge t nds, there is ne true structural break th series of forms of simia brains, this hiatus does not h bet ee ma nd the manlik pes, b t bet en the lo and the lo est simians, or in other ords, betwe th Old nd New World pes nd m k y nd th lemurs. Every lemur hich has t bee ex m ed, f ct, has ts cerebellum partially isible from abo nd ts posteri lobe th th co tai ed post ri cor nd hippocampus m or m re or less rudime tary E ery marmoset, America m nk y Old World m nke baboo manlike pe on th co trary has ts cerebellum tirely hidd n, post riorly by the cerebral lobes, nd possesses large posteri corn th ll-d loped hippocampus mi

This stat m t was trictly ccurat ccou t f what was kn h t as mad d t does not ppe t m t be more tha pparently eak ned by th bseque t disco ery of th relat ly sm ll d velopment of th posteri lobes the iama g and in the ho h g m nkey N t that nd g th ceptional bre ty of th post ri lobes these t pecies, no ne w ll pret nd that their brains, in th l htest degree pproach those of th lemurs. And if inst d of p tting Hapale t of ts natural place as Professo Bischoff most nacco tably does, writ th series of imals h has hose t m f f ll w H mo, I thecus, Troglodytes, Hylobates, Semnopithecus, Cynocephalus, C reopithecus, M cacus, Cebus, C llithrix, H pale Lemur tenops, I ture to reaffirm that the gre t break in

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Flo er 'O the Anat my of P thecs M nachus, Proc ed g of th Zoological Society 1862.
M Place Nat p. 102.

give a brief summary of the chapters in this First Part

NOTE ON THE RESEMBLANCES AND DIFFERENCES IN THE STRUCTURE AND THE DEVELOPMENT OF THE BRAIN IN MAN AND APES BY PROFESSOR HUXLEY F R S

The controversy respecting the nature and the extent of the diff rence in the structure f the b in m man and th ap s wl ch ros me fifteen y ars ag ha not yet com t

u gul r p rti n ity th t the b a n f all th apes even t e l gh t d ffers fr m that f m n the al nce of such conspicu us stru t f the cer bral mu f th late l r contained in man

the truth that the structur in question are as ll de l ped in apes as n hum n b ans or ver bett r and that t is ch racteri tic of all the primate (if ex lude the l mur) to ha the e parts well d velop d tands at p es nt n a cure a b s a any pr pos tion n omparati anatomy M reo it s dmitted by ev ry f t long ser of naton ts h of l

p ed fte the r re pat t n t h t s t tl F y p r e pal gyrus t l sulcu of a ch mpa z e l

t p no Sor y ars m Prof e B ch ff publ led tl

t s espe t l m gl d to m ke a tt t n f om l m

That the pes nd e pec ally tl rang ch m p n ee nd go ll com se y cl e t n th r orga isat o mu h tl n t ng th n n l well k n f ct di p ted by nobody Look g at tl e tter fr m tl po nt f f ga s t alo pr bably ul l h e d puted th f L nnaeus that m n l uld be pl ced merely a pecul pe t tl h a l f th n t m l all th

r t d ff ce wl h r lly t So t is w th tl b s Tl b a n f m tl tl ch mp zee tl g ll p t f ll tl mport t d ff en wl l th y present com e y close t o e an th (loc c t p 101)

There remains, then no di pute as to the resembl e in fundam ntal char ters, bet een the pe bra n and man s as to the wo d rfully close s mil rity betwee the cl mpanzee oran nd m n m the deta l of the arrang m nt f the gyri n l sulci f the cerebr l hem pheres. Nor turn g t th d ffere ce

t that the man s cer bral pl res a e absolutely n l rel g r than th is fœ tal trus n of

ss ymm tr cally l po ed a d pr se t gr ter nu ber f eco d y pl cat ons A d it is dmitted th t s a rule t ma the t mporo-occipit l r xt r l perp n c l r fissur h is usu lly s tro gly m ked a f ature of tl pe br n but fa rly m rked But t is also cl ar that ne f tle d ff r con t tutes a harp de m c t b t een the m n s a d the ape bra n In r pe t to th ext al perpend cul r fissure of tiol t the hum brai f r inst nce Professor Turner re arks

t th r gh t hemisphere f fe n l r n pas e tl t o ch o t nl nd o tl pec m l o the r ght h m pl r t proceeded f r f r t tl s f n ch ut nl d th xt ded do rd s f r as the l r r gin f tl e ut surf ce f the h m ph re Th impe fect d f t f tl fissu the m j rity f human b s, a compa ed w th ts r k lle l t t as tl b f most Quadru o g t th pr ce the f rm f cert n upe fi l ll ked condary co l is h l t e p th f the l tg th l t r (loc t p 12)

Th t f tl xt nal perpen l cul r fi u f Gr t l t tl r f r t a con ta t l t r f tl l l n O th h r han l t f ll f tl ce tl m re al perpe

cu t us ly t l k d tl tl l bee ted d g t f R ll t M M l ll M Br ll f T tl co lus f pre l p pe tl ul t tl l tt writes

Tl tl e pec f tl b a f l pa ee just l c bed pro tl t th ge ral sal wl l C t l t l tt pted t d w f tl e

[1] Die Grosshirnwindungen des Menschen Abh ndlu gen der K Bayerisch n Akadem B 1868.

((rol t n f tl H m Cer br m T po a h lly (nsd ed 1868 p 12.

Notes respecting the brain ... of the Chimp ... Proc d ... Royal Society f Ed ... gh 1865-6

panzee d f lmost ns g a i compared th that bet ee th h mpa ee l m d l

l

nimal mea described Th pe ll ual post f th second bridging co l l d tly l ss freq t nd ll l nly bee see the l (A)

l mur ry diff re t d acc dly g e t ll cons ly c g re tl b d

ll descrip ns, is as pec m s (pp 8 9)

E w re th prese ce f th t mpo o-occip tal, t rnal perpe d cul ulcus m k f l t c t bet ee th high pe tal m tl l f d t t haract uld be nd ed ry d btful by th tru ture f the bra th pl ty h pes I f t, whil th t mpo o-occ p t l

great gre t bre k tt gree of d l pm t f th co l t s, as fi d bet ee tl b f man d that f ang cl mpan ee

A haract h h is th bl th tl l m ts f gl gro p ha gre t t nom l

co l tu l b t t th tructur of th h le bra If Professo Bischoff had tak th tro ble t ref t p. 96 f tl k h crit ses, f ct, he ould h f d tl f ll g passag And t k ble rcum t nce that th gh, so far as ur prese t kno ledg t nds, th re tru tructural break th ers of f rms f bra ns, th l tus doe t l bet ee ma d th ma lik pes, b t bet ee th lo er nd th lowest im ns, ther w rds, bet ee th Old d N w W ld pes d m k y nd tl l murs. E ry l mur h h has y t bee m ed f ct ha ts cerebellum part lly usibl fro bo d ts post l be th th co t ed post co d h ppocampus m m less rud m tary E y marmoset Am rica m k y Old W ld m k y baboo m lik pe th co t ary h ts cerebellum t rely hidd post ri ly by th cereb l lobes, d possesse l post co th ll-d l ped h ppocampus m

Th tat m as tr tly ccur t eco t of hat kn h t mad l t does t ppe t m t be m re tha pp re tly ak d by th bseq t d sco ry f th relat ly sm ll d l pm t f th post l bes th sam g th h l g m k y N t tl t d g th cept l bre ty f th po t l bes these t pecies ll p t d that tl b is, th l ght t d gree pproa h those f th l murs. And f nst d f p tt g ll p l t of ts t l place l rof ss H h ff most ia co tably doe t th f imals h ha hose t m t f ll w H m l th cus, Troglodyt s, Hyl bat s, Sem p thecus, Cynocephal s, C reopithecu M cacus, C bus, C ll thrix, H pal Lem St ps, I ture to reaffirm that th gre t bre k in

d m re ymm tri al tha th Europ b hil m d duals f th ch mp zee th compl xity d a ymm try b com tabl Th is part cularly th as th bra of y g m l chimp nzee figured by M B oca. (L d d Pri at p 16a fig 11)

Agai respects th q est f b l t t is est blished th t th d ff re bet ee th largest d th smallest h lthy h ma bra is gre t th th differe ce bet ee th m ll t h lthy huma bra d th l g t himp nzee g bra

M eo there ircumstance h h th rang d chimp nzee brains resembl ma s, b t h h th y d ff f m th l pes, d th t th prese ce f tw co p ra cand ca tia—th C rpha ha g b t

I of thes fact I d t h t t th y 1874 t repeat d t po th p post h ch I nci ted 1863

Fl O th A t my f P th e M nachus P oc ed g f th Zool g al Society 1862.

M N t p 102.

this sere l es between Hapale and Lemur and th t this break is cons d rabl er n

— t tn separati n of the lemurs from the other pr mates on the very groun l of the differ ence in tl er c rebral ch racte s and that I rof ssor Flo er had made the f ll ing ob erv t ons in the course f h s d scription of the brain of the Javan loris [a]

And it i espec lly r markable that, in the devel pn ent of the poster or lobe th re is no pprox n ation to the lemurine short hemi phered brain i th e m nk ys l ch are co n i ly supposed to app oach thi family in other re pects viz the lo er m n b of the platyrhi group

So far as the structure f the adult brain s concerned then the ry considerable additi ns to ur kno ledge wh ch have b en made by th e earches of so many inv st gato s d ring th pa t te i years, fully ju tify the st tem nt which I i de in 1863 But it has been said that adm tt e simil r ty th y are nt b cause in the mode f th r developme it No one would b more r ady th n I to admit the fo e f th s rgum nt if such fundame tal difference f devel p nent re lly e ist. B t I d ny th t th y do ex t. O th co tr ry there is a fund mental g e m t

f

bra ns of ape and that f m i—con ting n th s th t n tl e pes tl e sulci which first make the appe rance are situated on th n f tus, es. s r- vatio th one of a g bbon al i st ready to be b r in wh ch the p st ri r gyri w re ell developed hile th s of th frontal l bes w re hardly indicated [77] (*loc cit* p 39) a d th other of

a human fœtus at the 2nd or 23rd week of utero-g station m vh ch Grati l t notes that the insula was uncov re l but that n rthel ss d neu m *semert de lobe antér i u se peu pr f nd ind q e la ép t n du lobe occip tal, t l -rid t, l'a ll urs dè cette époq e Le r t de la u f r cé ébrale e t e co e lisol t l e*

Three views of this brain are giv n n plate II figs 1 2 3 of the work c ted he ing the upper l t r l ar d u f r views f the h m ph res, but n t th inter v e. It is orthy of n te th t th figure ly no m ans be ut Grat l t s d scr pt inasmuch as th fis ure (ant ro-t mp ral) n the posteri r half f th f ce of the h m ph re i m re mark d than ny of th se gu ly indi ted n the anter or l alf If tl e figure is correct it in n way ju tifi s Gratiolet s conclu *H j donc e t e ces cer eaux* [thos of a C ll thrix nd f a gibbon] *ed s du fat s h ma u e d ffér nce fo d mental Ch ez c l -c t l gtemps ava t que l s pl s i mpor z appar e t l s pl s f tat* lop d the Busch and mo p t cularly by Eck r wh k is n t o ly th lat t b t ly f r the most cor plete men r n the ubject

Th final results of th r nqu ri s m y be summed up as f ll s —

1 In tl hum n fœtus, th syl n fiss re is fo ned in the c urs of the th rd m nth f ut roge tat o In th l m th f urth nontl th cereb l h n pl re are smootl nd rou ded f th

u g ng l tl e s xth m ntl f fœt l l f but E k r is ca ful to p nt out tl at n t ly th t n e but th rd f th r ppe ra ice s bject t co d r abl i d du l vari t n I i cas h ever re tl er the frontal or the t n p ral sulci the earl e t.

[a] Tr ns ctions of the *Zool gical Soci ty* vol. v 1862.

déve- ppe t Hal at t nt pem ns ge t al d lobe f ontal gé ulem nt pa ppo t d

a peine ma q t The figure ho r (pl fig 3) h ws the fis ure of R land d f th front l sulci plainly n ugh Ne rth l ss, M Al x in his N tice ur l s trav ux nthropol g q s de

Grat l t (*Mém de la Société d'Anth polog de l'aris* 1868 page 32) rites thus *C ut act eu d e l m l rre d fat d C lbo n et ém nemment pérrieu ett llem nt pprochéd l'or q d nat l t t è complètement nt gé parmi nt paul M H xl y pa zempl ht le pa po it. El bi t l rr d n fat d C bbo q G t ol t r l* t dis q hra E rch d i mphère des t th opol gie 1868

[77] *Zu l t* Ue ges l lt d F l d W l g n d Grossl rn Hem pl n m Fœtus des M nsch *f nth pologie* iii. 1868.

The first which appears, in fact, lies on the inner face of the hemisphere (whence doubtless Gratiolet, who does not seem to have examined that face in his fœtus, overlooked it), and is either the internal perpendicular (occipito-parietal), or the calcarine sulcus, these two being close together and eventually running into one another. It is as a rule the occipito-parietal the earlier of the two.

frontal, parietal, temporal and occipital lobes. There is, however, no clear evidence that one of these constantly appears before the other; and it is remarkable that, in the brain at the period described and figured by Ecker (loc. cit., pp. 212 [illegible] tab. II, figs. 1, 2, 3, 4), the antero-temporal sulcus (scissure parallèle) so characteristic of the ape's brain, is as well, if not better developed than the fissure of Rolando, and is much more marked than the proper frontal sulci.

Taking the facts as they now stand, it appears to me that the order of the appearance of the sulci and gyri in the fœtal human brain is in perfect harmony with the general doctrine of evolution, and with the view that man has been evolved from some ape-like form; though there can be no doubt that that form was, in many respects, different from any member of the primates now living.

Von Baer taught us, half a century ago, that, in the course of their development, allied animals put on at first, the characters of the greater groups to which they belong, and, by degrees, assume those which restrict them within the limits of their family, genus, and species; and he proved, at the same time, that no developmental stage of a higher animal is precisely similar to the adult condition of any lower animal. It is quite correct to say that a frog passes through the condition of a fish, inasmuch as at one period of its life the tadpole has all the characters of a fish, and if it went no further, would have to be grouped among fishes. But it is equally true that a tadpole is very different from any known fish.

In like manner the brain of a human fœtus, at the fifth month, may correctly be said to be not only the brain of an ape, but that of an arctopithecine or marmoset-like ape; for its hemispheres, with their great posterior lobules, and with no sulci but the sylvian and the calcarine, present the characteristics found only in the group of the arctopithecine primates. But it is equally true, as Gratiolet remarks, that, in its widely open sylvian fissure, it differs from the brain of any actual marmoset. No doubt it would be much more similar to the brain of an advanced fœtus of a marmoset. But we know nothing

who ex...
marmo...
servatio...
Pansch...
...s, in none of ...
deep calcarine fissure only ... very shallow antero-temporal fissure (scissure parallèle of Gratiolet).

Now this fact, taken together with the circumstance that the antero-temporal sulcus is present in such Platyrhini as the Saimiri, which present mere traces of sulci on the anterior half of the exterior of the cerebral hemispheres, or none at all, undoubtedly, so far as it goes, affords fair evidence in favour of Gratiolet's hypothesis, that the posterior sulci appear before the anterior, in the brains of the Platyrhini. But, it by no means follows, that the rule which may hold good for the Platyrhini extends to the Catarhini. We have no information whatever respecting the development of the brain in the Cynomorpha; and, as regards the Anthropomorpha, nothing but the account of the brain of the gibbon near birth, already referred to. At the present moment there is not a shadow of evidence to show that the sulci of a chimpanzee's, or orang's, brain do not appear in the same order as in man's.

Gratiolet opens his preface with the aphorism: *Il est dangereux dans les sciences de conclure trop vite.* I fear he must [illegible] forgotten this sound maxim by the time he had reached the discussion of the differences between men and apes, in the body of his work. No doubt, the excellent author of one of the most remarkable contributions to the just understanding of the mammalian brain which has ever been made would have been the first to admit the insufficiency of his data had he lived to profit by the advance of inquiry. The misfortune is that his conclusions have been employed by persons incompetent to appreciate their foundation, as arguments in favour of obscurantism.*

But it is important to remark that, whether Gratiolet was right or wrong in his hypothesis respecting the relative order of appearance of the temporal and frontal sulci, the fact remains that before either temporal or frontal sulci, appear the fœtal brain of man presents characters which are found only in the lowest group of the primates (leaving out the lemurs) and that this is exactly what we should expect to be the case if man has resulted from the gradual modification of the same form as that from which the other primates have sprung.

* For example, M. l'Abbé Lecomte in his terrible pamphlet, *Le Darwinisme et l'Origine de l'Homme*, 1873.

Part Two

Sexual Selection

CHAPTER VIII

PRINCIPLES OF SEXUAL SELECTION

WITH animals which have their sexes separated, the males necessarily differ from the females in their organs of reproduction; and these are the primary sexual characters. But the sexes often differ in what Hunter has called *secondary* sexual characters, which are not directly connected with the act of reproduction; for instance, the male possesses certain organs of sense or locomotion, of which the female is quite destitute, *or has them more* highly-developed, in order that he may readily find or reach her; or again the male has special organs of prehension for holding her securely. These latter organs, of infinitely diversified kinds, graduate into those which are commonly ranked as primary, and in some cases can hardly be distinguished from them; we see instances of this in the complex appendages at the apex of the abdomen in male insects. Unless indeed we confine the term "primary" to the reproductive glands, it is scarcely possible to decide which ought to be called primary and which secondary.

The female often differs from the male in having organs for the nourishment or protection of her young, such as the mammary glands of mammals, and the abdominal sacks of the marsupials. In some few cases also the male possesses similar organs, which are wanting in the female, such as the receptacles for the ova in certain male fishes, and those temporarily developed *in certain male frogs. The females of* most bees are provided with a special apparatus for collecting and carrying pollen, and their ovipositor is modified into a sting for the defense of the larvæ and the community. Many similar cases could be given, but they do not here concern us. There are, however, other sexual differences quite unconnected with the primary reproductive organs; and it is with these that we are more *especially concerned*—such as the greater size, strength, and pugnacity of the male, his weapons of offence or means of defence against rivals, his gaudy colouring and various ornaments, his power of song, and other such characters.

Besides the primary and secondary sexual differences, such as the foregoing, the males and females of some animals differ in structures related to different habits of life, and not at all, or only indirectly, to the reproductive *functions. Thus the females of certain flies* (Culicidæ and Tabanidæ) are blood-suckers, whilst the males, living on flowers, have mouths destitute of mandibles.[1] The males of certain moths and of some crustaceans (e. g. Tanais) have imperfect, closed mouths, and cannot feed. The complemental males of certain cirripedes live like epiphytic plants either on the female or the hermaphrodite form, and are destitute of a mouth and of prehensile limbs. In these cases it is the male which has been modified, and has lost certain important organs which the females possess. In other cases it is the female which has lost such parts; for instance, the female glow-worm is destitute of wings, as also are many female moths, some of which never leave their cocoons. Many female parasitic crustaceans have lost their natatory legs. In some weevil-beetles (Curculionidæ) there is a great difference between the male

in relation to different habits of life are generally confined to the lower animals; but with some few birds the beak of the male differs from that of the female. In the Huia of New

[1] Westwood, *Modern Classification of Insects*, vol. ii. 1840, p. 541. For the statement about Tanais, mentioned below, I am indebted to Fritz Müller. Kirby and Spence, *Introduction to Entomology*, vol. iii. 1826, p. 309.

Zealand th d ff re ce i wo d rf lly g e t, and h ar f om D B ller[1] tl at tl e male se hı t ng beak ı ch sell g th lar ae f ıns ts t f d ayed ood wh l t th f male p be th soft r p ts th h r far l g r m h rved d pl ant b ak d tl s th y m t lly d ach tl In mo t cas s, d ff ces f t tu b tw n the s e m re l ss d re tly connected with tl p p g ti n f the pec s th f m le wh cl has to n urısh a m ltıt de f a, eq m r food than tl mal a d cons q tly eq r speci l m s f r proc g t. A m l anımal, wh ch l es f y h t t m mght l se t gans f p oc g food tl gh d use w th t d t m t but h w ld eta h s locom ti ga n perf ct tat so tl t l might ach th fem l Th fem le tl

us l ss

W ar h he co cerned ly with

reprod ti Wh as th cases ab m t ed th t d ff n stru t n rel t t d ff th b ts f life th y l e n d btb mod fied thr gl tur l select and by h tance lım ted t d the sam So gai th p mary l g ns, and th e f n h g prot t g the y g com d r th sam fi ce f r th se di d al wh h g ted n hed th ff pri g b t ldl eet rasparıb th g t t mb to nl t th pe nty lul ttl se wh hg r t do led th e ff p g badly ld l b t f w t l nt tl k po ls th m l has t fi d

f m l h som t m bsol tely q es pre l ns l gans t h ld h th D W llace nf rm m th t th mal f certaın m th an t nıt th th f mal ıf th t r feet ar b k Th mal f many oc am crustacean wh ad lt h th ır l gs and t nnæ modified ın an t aord ry man f th p h ns f th f mal h n w m y pect th t t ıs because th se anımal ar

washed about by the w ves of the open sea, that prop n ı s lec sc l

i

pei

Wl n tl t sex f llow xactly tl e sa B b ts f l l and tl m le l as tl e sensory locom t ve gans m re h gl ly dev l ped tl an those f tl e f m l ıt m y b that tl e perf c t f th se ı ı d pensabl to tl e mal f r fi d g tl f male but n tl e vast m jority f

f r th ordı ary l b ts of l f S ce ın l case tl e m l l a acqu ed tl e prese t str t n t f m b g bett fitted t r

to tl l ff p g al se l select n must h e ha co t act It was tl importance f th distınctı which led me t

t th scape f tl f mal b f e the arrival f th r m l when assaulted by tl th g w ll h been perf cted tl ro gh l lecti n tl t m by th ad antag acq ed by certaın ınd ıdu l o er tl n als B t n m t ase of th kind ıt s ın possıbl to dist gu h b t ee th ffects of natural a d al el ct Wh l chapters

M P rr ad ce th as (Revu Sci nt f q F b. 1 1873 p 865) as f tal t th bel f

[1] B H f New Z aland 1872, p. 66

could be filled with details on the differences between the sexes in their sensory locomotive and prehensile organs As however these structures are not more interesting than others adapted for the ordinary purposes of life I shall pass them over almost entirely giving only a few instances under each class

There are many other structures and instincts which must have been developed through sexual selection—such as the weapons of offence and the means of defence—of the males for fighting with and driving away their rivals—their courage and pugnacity—their various ornaments—their contrivances for producing vocal or instrumental music—and their glands for emitting odours most of these latter structures serving only to allure or excite the female It is clear that these characters are the result of sexual and not of ordinary selection since unarmed unornamented or unattractive males would succeed equally well in the battle for life and in leaving a numerous progeny but for the presence of better endowed males We may infer that this would be the case because the females which are unarmed and unornamented are able to survive and procreate their kind Secondary sexual characters of the kind just referred to will be fully discussed in the following chapters as being in many respects interesting but especially as depending on the will choice and rivalry of the individuals of either sex When we behold two males fighting for the possession of the female or several male birds displaying their gorgeous plumage and performing strange antics before an assembled body of females we cannot doubt that though led by instinct they know what they are about and consciously exert their mental and bodily powers

Just as man can improve the breeds of his game cocks by the selection of those birds which are victorious in the cock pit so it appears that the strongest and most vigorous males or those provided with the best weapons have prevailed under nature and have led to the improvement of the natural breed or species A slight degree of variability leading to some advantage however slight in reiterated deadly contests would suffice for the work of sexual selection and it is certain that an erect and peculiar carriage—so it appears that female birds in a state of nature have by a long selection of the more attractive males added to their beauty or other attractive qualities No doubt this implies powers of discrimination and taste on the part of the female which will at first appear extremely improbable but by the facts to be adduced hereafter I hope to be able to shew that the females actually have these powers When however it is said that the lower animals have a sense of beauty it must not be supposed that such sense is comparable with that of a cultivated man with his multiform and complex associated ideas A more just comparison would be between the taste for the beautiful in animals, and that in the lowest savages, who admire and deck themselves with any brilliant glittering or curious object.

From our ignorance on several points, the precise manner in which sexual selection acts is somewhat uncertain Nevertheless if those naturalists who already believe in the mutability of species will read the following chapters they will I think agree with me that sexual selection has played an important part in the history of the organic world It is certain that amongst almost all animals there is a struggle between the males for the possession of the female This fact is so notorious that it would be superfluous to give instances Hence the females have the opportunity of selecting one out of several males on the supposition that their mental capacity suffices for the exertion of a choice In many cases special circumstances tend to make the struggle between the males particularly severe Thus the males of our migratory birds generally arrive at their places of breeding before the females so that many males are ready to contend for each female I am informed by Mr Jenner Weir that the bird catchers assert that this is invariably the case with the nightingale and blackcap and with respect to the latter he can himself confirm the statement

Mr Swaysland of Brighton has been in the habit, during the last forty years, of catching our migratory birds on their first arrival and he has never known the females of any species to arrive before their males During one spring he shot thirty nine males of Ray's wagtail (*Budytes raii*) before he saw a single female Mr Gould has ascertained by the dissection of those snipes which arrive the first in this country that the males come before the females And the like holds good with most of

[illegible] acquired by the parent species can give to the Sebright bantam a new and elegant plumage

th m grato y b rd f the Unit d Stat The m jo tv f th male salmon n coming up from the sea, are ready to b eed bef re tl e femal s. So t ppe to b w th frogs and t ad Thro gh t tl e gre t class f sects th m l s alm t alw are th first to m g from tl e p p l tat so tl at th y ally l u d f tum l f e any f m les can be see Tl e a se f tl d ff r ce b t tl m l and f mal th r period of

ady t b eed w th m t r w l a th large t n mb r f ff pri g nd tl se ld t d t inherit m lar t ts cts f co t t t It mu t be b e mu d

y ung— period th seasons f tl y ar O tl h l th re ca b d bt tl t th lmost all mals, n hi l tl a par le tl a co t tly ec t truggl between th m l f th possess f th f mal

diff lty reg rd t se al select n l d tand g l t th t th mal hich co q th m l s, th se wh ch pro tl m t tt acti t th f m l l g eat umb f ff pri to inh t tl r pe rity tl tl b t and l ss ttrac ti als. l l ss tl lt does f llow tl e haract l h t ce t mal an ad antag th s, ld t b perfected and gm ted tl hse l lect n. Wh n th ex xi t actl q al mbers, th rst-e d ed l w ll (ce t wh polyg m p ul) ltim t l fi d f m l s, and l s man ff p g as ll fitted f th ir al h b t f l f as tl b t d ed m l F m facts and nsid rat l f m ly nf ed tl t with m t animals, in wl h sec dary se l haracte ar w ll d l ped tl m l co d bly c ed d

tl e f m l s in number b t tl is ot by any ca s l ay true If th males w re to tl e f m l s as two to o or as tl re t two or e e a sot e lat l we r t o, tl e wl le l l l for tl b tt r ar ed

eq al ty numl co nm ls xists In t t case sex al select n ppears to have been effect the f ll g m an er

m re b als, and th tl r f the l ss g ro s a l lealtl y Tl e form tl e can be l ttl d lt wo ld be r ad to breed n tl pring bef re th tl rs and thu s tl n of M J n n W wl o has ar f lly tte ded to tl e l b ts f b rd d ri g many y rs. There can lso be d bt tl t tl most us, be l n rished and e l t l ed s w ll an ge ceed rear tl largest nu ber f ff pring Th males, as w l een are gene ally ready t l eed bef re tl e f m l tl tro g t, and w th some pec s tl l t armed f the males, dri a y tl e w ak an l tl e f m wo ld tl t w tl tl m re g ro and b tt n ri l ed femal s, because they are tl first to breed S ch g ro pairs w ld ly rear a larg mbe f ff p i g than tl tarded f mal s, wl h w ll b compelled t unite w th tl e co qu red and l pow f l m l s, ppo ng tl se t be n m rically q al and th all tl t wanted t add th co se f ccess r t ns t tl e tre gth d coura g f tl m l to impro th weapo

B t in ry many case th males wl ch co q th r m ls, do n t obtain possess f the f mal d pe d ntly f the ch ce f

Hre cell t d ce th ch t f th ff p g from exper ced th l gust. M J A All pe k (M mmal nd W nter B ds f E Flori p 229) f th l t broods, It th ac-

ral tl b d f th l b oods seem ll re-

hich th f mal g na ar bef re-ha d.

the latter The courtship of animals is by no means so simple and short an affair as might be thought The females are most excited by or prefer pairing with the more ornamented males or those which are the l r

r

t more vigorous and lively males and this has in some cases been confirmed by actual observation [3] Thus the more vigorous females which are the first to breed will have the choice of many males and though they may not always select the strongest or best armed they will select those which are vigorous and well armed and in other respects the most attractive Both sexes therefore of such early pairs would as above explained have an advantage over others in rearing offspring and this apparently has sufficed during a long course of generations to add not only to the strength and fighting powers of the males but likewise to their various ornaments or other attractions

In the converse and much rarer case of the males selecting particular females it is plain that those which were the most vigorous and had conquered others would have the freest choice and it is almost certain that they would select vigorous as well as attractive females Such pairs would have an advantage in rearing offspring more especially if the l the ring am of the young The same principles would apply if each sex preferred and selected certain individuals of the opposite sex supposing that they selected not only the more attractive but likewise the more vigorous individuals

Numerical Proportion of the Two Sexes —I have remarked that sexual selection would be a simple affair if the males were considerably more numerous than the females Hence I was led to investigate as far as I could the proportions between the two sexes of as many animals as possible but the materials are scanty I will here give only a brief abstract of the results retaining the detail for a supplementary discussion so as not to interfere with the course of my argument Domesticated animals alone afford the means of ascertaining the proportional numbers at birth but no records have been specially kept for this purpose By indirect means, however I have collected a considerable l a

births of race horses have been recorded during twenty one years and the male births were to the female births as 99 to 100 In greyhounds the inequality is greater than with any other animal for out of 6878 births during twelve years the male births were to the female as 110 1 to 100 It is however in some degree doubtful whether it is safe to infer that the proportion would be the same under natural conditions as under domestication for slight and unknown differences in the conditions affect the proportion of the sexes Thus with mankind the male births in England are as 104 5 in Russia as 108 9 and with the Jews of Livonia as 120 to 100 female births But I shall recur to this curious point of the excess of male births in the supplement to this chapter At the Cape of Good Hope however male children of European extraction have been born during several years in the proportion of between 90 and 99 to 100 female children

For our present purpose we are concerned with the proportions of the sexes, not only at birth but also at maturity and this adds another element of doubt for it is a well ascertained fact that with man the number of males dying before or during birth and during the first two years of infancy is considerably larger than that of females So it almost certainly is with male lambs and probably with some other animals The males of some species kill one another by fighting or they drive one another about until they become greatly emaciated They must also be often exposed to various dangers whilst wandering about in eager search for the females In many kinds of fish the males are much smaller than the females and they are believed often to be devoured by the latter or by other fishes The females of some birds appear to die earlier than the males they are also liable to be destroyed on their nest whilst in charge of their young With insects the female larvæ are often larger than those of the males, and would consequently be more likely to be devoured In some cases the mature females are less active and less rapid in their movements than the males, and could not escape so well from danger Hence with animals in a state of

nature, we must rely on mere estimation, in order to judge of the proportions of the sexes at maturity; and this is but little trustworthy, except when the inequality is strongly marked. Nevertheless, as far as a judgment can be formed, we may conclude from the facts given in the supplement, that the males of some few mammals, of many birds, of some fish and insects, are considerably more numerous than the females.

The proportion between the sexes fluctuates slightly during successive years: thus with race-horses, for every 100 mares born the stallions varied from 107.1 in one year to 92.6 in another year, and with greyhounds from 116.3 to 95.3. But had larger numbers been tabulated throughout an area more extensive than England, these fluctuations would probably have disappeared; and such as they are, they would hardly suffice to lead to effective sexual selection in a state of nature. Nevertheless, in the case of some few wild animals, as shewn in the supplement, the proportions seem to fluctuate either during different seasons or in different localities in a sufficient degree to lead to such selection. For it should be observed that any advantage, gained during certain years or in certain localities by those males which were able to conquer their rivals, or were the most attractive to the females, would probably be transmitted to the offspring, and would not subsequently be eliminated. During the succeeding seasons, when, from the equality of the sexes, every male was able to procure a female, the stronger or more attractive males previously produced would still have at least as good a chance of leaving offspring as the weaker or less attractive.

Polygamy.—The practice of polygamy leads to the same results as would follow from an actual inequality in the number of the sexes; for if each male secures two or more females, many males cannot pair; and the latter assuredly will be the weak or less attractive individuals. Many mammals and some few birds are polygamous, but with animals belonging to the lower classes I have found no evidence of this habit. The intellectual powers of such animals are, perhaps, not sufficient to lead them to collect and guard a harem of females. That some relation exists between polygamy and the development of secondary sexual characters, appears nearly certain; and this supports the view that a numerical preponderance of males would be eminently favourable to the action of sexual selection. Nevertheless many animals, which are strictly monogamous, especially birds, display strongly-marked secondary sexual characters; whilst some few animals, which are polygamous, do not have such characters.

We will first briefly run through the mammals, and then turn to birds. The gorilla seems to be polygamous, and the male differs considerably from the female; so it is with some baboons, which live in herds containing twice as many adult females as males. In South America the *Mycetes caraya* presents well-marked sexual differences, in colour, beard, and vocal organs; and the male generally lives with two or three wives: the male of the *Cebus capucinus* differs somewhat from the female, and appears to be polygamous.[10] Little is known on this head with respect to most other monkeys, but some species are strictly monogamous. The ruminants are eminently polygamous, and they present sexual differences more frequently than almost any other group of mammals; this holds good, especially in their weapons, but also in other characters. Most deer, cattle, and sheep are polygamous; as are most antelopes, though some are monogamous. Sir Andrew Smith, in speaking of the antelopes of South Africa, says that in herds of about a dozen there was rarely more than one mature male. The Asiatic *Antilope saiga* appears to be the most inordinate polygamist in the world; for Pallas states that the male drives away all rivals, and collects a herd of about a hundred females and kids together; the female is hornless and has softer hair, but does not otherwise differ much from the male. The wild horse of the Falkland Islands and of the western states of N. America is polygamous, but, except in his greater size and in the proportions of his body, differs but little from the mare. The wild boar presents well-marked sexual characters, in his great tusks and some other points. In Europe and in India he leads a solitary life, except during the breeding season; but as is believed by Sir W. Elliot, who

Sir Andrew Smith, *Illustrations of the Zoology of S. Africa*, 1849, pl. 29, on the Kobus. Owen in his *Anatomy of Vertebrates* (vol. iii, 1868, p. 633) gives a table shewing incidentally which species of antelopes are gregarious.

has had many opportunities in India of observing this animal he consorts at this season with several females Whether this holds good in Europe is doubtful but it is supported by some evidence The adult male Indian elephant, like the boar passes much of his time in solitude but as Dr Campbell states when with others It is rare to find more than one male with a whole herd of females the larger males expelling or killing the smaller and weaker ones The male differs from the female in his immense tusks greater size strength and endurance so great is the difference in these respects that the males when caught are valued at one fifth more than the females [12] The sexes of other pachydermatous animals differ very little or not at all and as far as known they are not polygamists Nor have I heard of any species in the Orders of Cheiroptera Edentata, Insectivora and rodents being polygamous excepting that amongst the rodents the common rat according to some rat catchers lives with several females Nevertheless the two sexes of some sloths (Edentata) differ in the character and colour of certain patches of hair on their shoulders [13] And many kinds of bats (Cheiroptera) present well marked sexual differences chiefly in the males possessing odoriferous glands and pouches and by their being of a lighter colour [14] In the great order of rodents as far as I can learn the sexes rarely differ and when they do so it is but slightly in the tint of the fur

As I hear from Sir Andrew Smith the lion in South Africa sometimes lives with a single female but generally with more and in one case was found with as many as five females so that he is polygamous As far as I can discover he is the only polygamist amongst all the terrestrial Carnivora and he alone presents well marked sexual characters If however we turn to the marine Carnivora, as we shall hereafter see the case is widely different for many species of seals offer extraordinary sexual differences and they are eminently polygamous Thus according to Peron the male sea elephant of the southern ocean always possesses several females and the sea lion of Forster is said to be surrounded by from twenty to thirty females In the North the male sea bear of Steller is accompanied by even a greater number of females. It is an interesting fact, as Dr Gill remarks [15] that in the monogamous species or those living in small communities there is little difference in size between the male and females in the social species, or rather those of which the males have harems, the males are vastly larger than the females.

Amongst birds many species the sexes of which differ greatly from each other are certainly monogamous In Great Britain we see well marked sexual differences, for instance, in the wild-duck which pairs with a single female the common blackbird and the bullfinch which is said to pair for life I am informed by Mr Wallace that the like is true of chatterers or Cotingidæ of South America, and of many other birds. In several groups I have not been able to discover whether the species are polygamous or monogamous. Lesson says that birds of paradise so remarkable for their sexual differences are polygamous, but Mr Wallace doubts whether he had sufficient evidence Mr Salvin tells me he has been led to believe that humming birds are

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black cock differ greatly from the females whilst the sexes of the monogamous red grouse and ptarmigan differ very little In the Cursores, except amongst the bustards few species offer strongly marked sexual differences, and

[12] Dr Gray in *An al ... ag gaz ... History* 1871 p 302.

[13] See Dr Dobson ... cell t paper ... *Proceedings of the Zoological Society* 18 3 p 241

[15] The Eared Seals, *American Naturalist* vol. i Jan 1871

The Ib
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pe k f th black grouse as polyg m us nd of to red grouse as m gam us.

the gre t bustard (Oti t rd) s said to be pol, gamous. With the Grallat res, xtrem ly f w pecies diff r sexuall b t the ruff (Machete p gnax) aff rds marked except n, and this pecies is bel e ed by M ntagu to be pol gamist. Hence t ppears th t am g t birds th re often xists close relation between pol gamy and th d lopm nt of strongly marked se al diff rences. I asked Mr Bartlett, f th Zoological Gard ns, who has had ry larg xpe ce with b rds, wheth th male trag pan (ne f th Gallinaceæ) was pol gamous, and I was struck by his answ ring, I d not know b t sh ld think so from hi plendid colours.

It deserv notice that th instinct of pairing with singl female is easil lost und r domestication. Th w ld-d ck is str ctly monogamo s, th d mestic-d k l ghly polygamous. Th R W D Fox inf rms me that out of som half tamed wild-d cks, on a large pond in his gl bo hood so man mallards w re shot b th game-keepe that only on was l ft for ry se n or ght f males y t unusuall larg broods w re reared The guine f wl stri tly m nogamous b t Mr F x find th t his birds succeed best wh n he keep cock to tw three h s. Canary birds pair tat of nature b t the breed rs F l nd successf ll p t mal to f ur

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far as can judge, sexual selecti has led to the d lopm t f secondary sexual characters. It has bee sh wn that th largest numbe of vi ro ffspring will be reared from th pa ring f th tro gest and be t armed males, vict ri us in cont ts o th mal s, with th most rous and best nourished f mal s, whi h are th first t breed in th spring If h f mal select th m re ttrac m re attract e and t the same t me h al hy and vigoro s females and this will especi lly hold good f the male d f nds th femal and aids pro iding food fo the y ung Th ad antag thus gai ed by th e more gorous pairs n rearing a large number of off pri has pparentl sufficed to render sexual selection ffici nt B t a large n merical p po d rance f males er f males w ll be till more ffici nt wheth r the preponderance s nl occasi nal and local, or perman nt wh th r t occurs t birth, o afterwards from th gre ter destruction of the females or wh th r t indirectl f llo s from the practice of pol gamy

The Male generally more mod fied tha the Female —Througho t the animal kingd m, when th sexe diff in xternal appearance t is, w th rare exceptions, th male which has een all the

m mbers of th same group. The cause of seems t b th the males of almost all anim als h ing tro ger passion than th females. Hence t is th males that fight tog ther and sedulousl d pl thei charms bef re th females and th tors transmit th superi t th mal off pring. Why both sex s do n t thu acquire th haracters of th ir f th rs, will be consid red hereaft That the male of all mammals ag l pursu th f m les n tori us to ry one So t is with bird b t many cock b rd d not so much pursu th e h n, as display th pl mage, perform tra e antics, and po f rth th so g in h presence Th m l n th f w fish observed seems m ch m re than th f mal and the sam m tru of all gators, and pparentl of batrachians. Thro gh t th nor o l ss f insects, as Kirb remarks, th law is th t th mal shall seek the f male. [1] Two goo l authorit es, Mr Blackw ll and M C Spe ce B t t ll m th t the males f p l rs d crustaceans are m re acti and more rrat in their hab ts than th f males. Wh n th rgans of sense locomoti are present th se f nsect and crustacean d absent in th th wh as freq tly th case th are m re h hly d loped in th than th th t is, as far as I can disco almost ariably th m l wh h retains l rg s has th m most d l

Noel Humphreys, R ver Ga dens, 1857

[1] K rby nd pe ce *Introductio to Entomology* vol. ii., 1826 p. 342.

has had many opportunities in India of observing this animal he consorts at this season *with several females* *Whether this holds good* in Europe is doubtful but it is supported by some evidence The adult male Indian elephant like the boar passes much of his time in solitude but as Dr Campbell states when with others It is rare to find more than one male with a whole herd of females the larger males expelling or killing the smaller and weaker ones The male differs from the female in his immense tusks greater size strength and endurance so great is the difference in *these respects that the males when caught are* valued at one fifth more than the females [12] The sexes of other pachydermatous animals differ very little or not at all and as far as known they are not polygamists Nor have I heard of any species in the Orders of Cheiroptera Edentata, Insectivora and rodents being polygamous excepting that amongst the rodents the common rat according to some rat catchers lives with several females Nevertheless the two sexes of some sloths (Edentata) *differ in the character and colour of certain* patches of hair on their shoulders [13] And many kinds of bats (Cheiroptera) present well marked sexual differences chiefly in the males possessing odoriferous glands and pouches and by their being of a lighter colour [14] In the great order of rodents as far as I can learn the sexes rarely differ and when they do so it is but slightly in the tint of the fur

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[illegible] *Procced-* [illegible]

[15] 'The Eared Seals,' *American Nat* [illegible] 1871

[16] *The Ibis* [illegible] 1861 p 133 [illegible] widow bird. See also [illegible] 1860 p 211 On the polyg[amy of] the caper[cailzie] [illegible] see L. Lloyd *Game Birds* [illegible] 1867 pp 19 and 182 M[ontagu] and Selby speak of the black grouse as polygamous and of the red grouse as monogamous.

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oped and this shews that the male is the more active member in the courtship of the sexes [19]

The female on the other hand with the rarest exceptions is less eager than the male As the illustrious Hunter[20] long ago observed she generally requires to be courted she is coy and may often be seen endeavouring for a long time to escape from the male Every observer of the habits of animals will be able to call to mind instances of this kind It is shown by various facts given hereafter and by the results fairly attributable to sexual selection that the female though comparatively passive generally exerts some choice and accepts one male in preference to others Or she may accept as appearances would sometimes lead us to believe not the male which is the most attractive to her but the one which is the least distasteful The exertion of some choice on the part of the female seems a law almost as general as the eagerness of the male

We are naturally led to enquire why the male in so many and such distinct classes has become more eager than the female so that he searches for her and plays the more active part in courtship It would be no advantage and some loss of power if each sex searched for the other but why should the male almost always be the seeker? The ovules of plants after fertilisation have to be nourished for a time hence the pollen is necessarily brought to the female organs—being placed on the stigma by means of insects or the wind or by the spontaneous movements of the stamens and in the Algæ &c by the locomotive power of the antherozooids With lowly organised aquatic animals permanently affixed to the same spot and having their sexes separate the male element is invariably brought to the female and of this we can see the reason for even if the ova were detached before fertilisation and did not require subsequent nourishment or protection there would yet be greater difficulty in transporting them than the male element because being larger than the latter they are produced in far smaller numbers So that many of the lower animals are in this

natural that any of their descendants which rose in the scale and became locomotive should retain the same habit and they would approach the female as closely as possible in order not to risk the loss of the fertilising element in a long passage of it through the water With some few of the lower animals, the females alone are fixed and the males of these must be the seekers But it is difficult to understand why the males of species of which the progenitors were primordially free should invariably have acquired the habit of approaching the females instead of being approached by them But in all cases in order that the males should seek efficiently it would be necessary that they should be endowed with strong passions and the acquirement of such passions would naturally follow from the more eager leaving a larger number of offspring than the less eager

The great eagerness of the males has thus indirectly led to their much more frequently developing secondary sexual characters than the females But the development of such characters would be much aided if the males were more liable to vary than the females—as I concluded they were—after a long study of domesticated animals Von Nathusius, who has had very wide experience is strongly of the same opinion [22] Good evidence also in favour of this conclusion can be produced by a comparison of the two sexes in mankind During the Novara expedition[23] a vast number of measurements was made of various parts of the body in different races and the men were found in almost every case to present a greater range of variation than the women but I shall have to recur to this subject in a future chap-

I f S l (*Lch b h der Bot* l 18 0 s. 633) in p k g f th n l d f m l rep rod t cell r m rks, *erhält ich d e eine bei der l ere g g ct d nd e sel t bei d l erei*

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Es ys and Observations edited by O n v L s. 1861 p 194

1867 ss.

[22] W s-bach f m n n t d by D s. K Sch rz r a d Sch rz. O th gre t r b l ty f th n l s f d m t ted m ls, see my *I at f A mal nd Pl nt nder D mest atio* l. 1868 p 5

co q rin, ther males in battl r courtship, and thus l ving m ro progen are n the long run great than tl ose d ri ed from rath m re pe fect adaptat t th ir cond tions f life W shall f rth see and it co ld ne have bee ant cipated th t the power to charm th f mal has som tim been m re important than th pow to co q c oth males in battle

Laws of Inheritance.

th la of inh ritance as far as th are known. Tw d tinct l m ts are incl d d under th term inh ritance"—th transm s-sion, and th d lopm nt f haract rs b t as these g rally go t th th di t ncti n is oft looked W see this distin ti n in those charact rs which are transmitted through th arly ears f lif b t are d l ped nly

both se es, tho gh d loped in lo Th t th y are prese t both se es, is mani fest wh t species, ha ing trongly marked

act rs prope to th male are occasi nally d loped in th f mal wh n sh grow ld o becomes diseased as, f nstance whe the comm h assumes th flowing tail feath rs, hackles, comb, purs, o ce and n p g nacit f th cock. Co rsel th sam thi g nd t, m re less plainl with castrated males. Agam, nd pend tl f ld ag disease charact rs are occas nall trans. rred from th mal t th f m l as wh n n ce tai breed f th f wl, purs regularl ppear th g and health f males. B t truth th are simpl d eloped in th f mal f m ev ry breed ach d tail in th tru ture f th p transmitted thro gh th f male t h mal offspring Man ases will h reaft be gi n, wh re th f mal xhib ts, more o less perfectl haract rs prope to th m l n hom th must ll been first d l ped, and th transf rred t th f mal Th con- rse case of the first dev lopm t of char act rs th f mal and of transf re ce to th m le is less freq ent t will th ref re be well to gi e one strik g instance W th bees the poll n-collecting apparatus is used by the f mal alone f r g th ring pollen f r the larvæ t n mo t of tl e pecies it s partiall de l ped n the males t al m it is quite use-less, and it is perfectly de eloped in the males of Bombu o the h ll bee ³³ As ot a si gle ther hymenopterous insect not e en th wasp which is closely all ed to the bee is pro-vided with pollen-collecting ppar t s we ha e n grounds for pposi g th t male bees prim rdiall collected pollen as w ll as th f males altho gh we have some reason to pect that male mammals prim rd ally u kled th r young as w ll as th f males. Lastl in all cases of re rsi n, charact rs re transm tted through t o, three, or many m re g erati ns, and are th n de loped under certain nkn wn f rable cond ti ns. Th s important d ti cti n between transmiss on and d lopm t will be best k pt n mind l v th aid of th h pothesis of pang nesis. Ac-cord g to this h poth s, ry unit cell f th bod throws off gemmules r unde loped t ms, which are t ansmitted t th offspri g f both se s, and are multiplied by self divisi n. Th y m y remai und vel ped d ing th arly ars of l f o d ri g cess e ge erati ns and th r d lopment t un ts o cells, lik th se from which th y w re de-ri ed d pends th affi t s fo and nion w th th units r cells pre usly de l ped in th d ord r f growth.

th hand, a n w haracte ppears at ma turity o n d ring ld g t t nds to re ppear in th ff pri g t th same ad anced age. When d viat ns from this rule occur th transm tted characters m ch ft n ppear bef re than aft th corresponding As I h e dw lt n this bject sufficiently in an th w k,³⁴ I w ll h re merely gi two three nstances, f th sak f recalling th bject to th read mind In se al breed

nounced secondary sexual characters, such as brighter colours, greater size, strength, or pugnacity. With birds there has sometimes been a complete transposition of the ordinary characters proper to each sex; the females having become the more eager in courtship, the males remaining comparatively passive, but apparently selecting the more attractive females, as we may infer from the results. Certain hen birds have thus been rendered more highly coloured or otherwise ornamented, as well as more powerful and pugnacious than the cocks; these characters being transmitted to the female offspring alone.

It may be suggested that in some cases a double process of selection has been carried on; that the males have selected the more attractive females, and the latter the more attractive males. This process however, though it might lead to the modification of both sexes, would not make the one sex different from the other, unless indeed their tastes for the beautiful differed; but this is a supposition too improbable to be worth considering in the case of any animal, excepting man. There are, however, many animals in which the sexes resemble each other, both being furnished with the same ornaments, which analogy would lead us to attribute to the agency of sexual selection. In such cases it may be suggested with more plausibility, that there has been a double or mutual process of sexual selection; the more vigorous and precocious females selecting the more attractive and vigorous males, the latter rejecting all except the more attractive females. But from what we know of the habits of animals, this view is hardly probable, for the male is generally eager to pair with any female. It is more probable that the ornaments common to both sexes were acquired by one sex, generally the male, and then transmitted to the offspring of both sexes. If, indeed, during a lengthened period the males of any species were greatly to exceed the females in number, and then during another lengthened period, but under different conditions, the reverse were to occur, a double, but not simultaneous, process of sexual selection might easily be carried on, by which the two sexes might be rendered widely different.

We shall hereafter see that many animals exist, of which neither sex is brilliantly coloured or provided with special ornaments, and yet the members of both sexes or of one alone have probably acquired simple colours, such as white or black, through sexual selection. The absence of bright tints or other ornaments may be the result of variations of the right kind never having occurred, or of the animals themselves having preferred plain black or white. Obscure tints have often been developed through natural selection for the sake of protection, and the acquirement through sexual selection of conspicuous colours appears to have been sometimes checked from the danger thus incurred. But in other cases the males during long ages may have struggled together for the possession of the female, and yet no effect will have been produced, unless a larger number of offspring were left by the more successful males to inherit their superiority, than by the less successful; and this, as previously shewn, depends on many complex contingencies.

Sexual selection acts in a less rigorous manner than natural selection. The latter produces its effects by the life or death at all ages of the more or less successful individuals. Death, indeed, not rarely ensues from the conflicts of rival males. But generally the less successful male merely fails to obtain a female, or obtains a retarded and less vigorous female later in the season, or, if polygamous, obtains fewer females; so that they leave fewer, less vigorous, [illegible] ... regard to structures ac[illegible]

[illegible]

of advantageous modification in relation to certain special purposes; but in regard to structures adapted to make one male victorious over another, either in fighting or in charming the female, there is no definite limit to the amount of advantageous modification; so that as long as the proper variations arise the work of sexual selection will go on. This circumstance may partly account for the frequent and extraordinary amount of variability presented by secondary sexual characters.

[illegible]

injurious, either by expending too much of their vital powers, or by exposing them to any great danger. The development, however, of certain structures—of the horns, for instance, in certain stags—has been carried to a wonderful extreme; and in some cases to an extreme which, as far as the general conditions of life are concerned, must be slightly injurious to the male. From this fact we learn that the advantages which favoured males derive from

sexual d m larity nd complete I rit Instance h lready been gi n w th tle breed f th f l and p geo and l r t re nal go case are comm n W th ani mal und r d m t t on, but wh tl n t I will t e ture t say n se m y lose cl aract s prope t it, and m y th s com som wh t to resemble th oppo t se f tance tl m l f s m breed f the f l b l t th masc l e tail pl m and hackl O the th l and th d ffere ces b twee sexes m v b creased u d r d m ti t on, as th m in sl eep n wh h th w h l t the h s. Ag in, cl act rs proper to se m y dd ly ppe r the th se as i th se b b eed f the f l which the h n acq re p wl bt y ung ce tai P l sh b-b eeds, in wh ch th f m l as tl re reaso t be

g es f th y d pe d th g mm l f ce tai parts, alth gh prese t botl s, becomi g thr gh the nfl nce f d m t ca t n, eith d mant d l ped n th se

Th re is d fficult q t o wh h t will be co t to d f t f ture ch pt r m ly h th h act t first d l ped in both se s, could thro gh select be l m ted ts d l pm t t se l lf f t ce b eed bserved th t som f l p geo (f h cl th charact rs ar ally t ansf rred an q al d gree t b th se) aried into p f bl co ld h by l g-co t ed selecti mak breed, wh ch th mal al l ld b f th t t, whil t th f m l mai ed hanged I w ll l ly say th t th s, th gh p h p t mposs bl w ld b t m l d ffi lt f tl t l lt f breed g from tl p l bl m les ld be to l g th h l tock f b tl se t th t I If h w ar t f th d ed ti t ppe ed wl l from th t lim ted th d l pm t t th male se th re w ld t b th l ast d ffi ult making b eed tl th t se f dif f re t col as deed l as bee ffected w tl B lgian breed which th m l l are treaked with black I m lar mann if any ari t pp ared f mal p which was f m th first sexually l m ted t d l pm t to th f m l s, t w ld b asy to mak breed with th f m l l th charact rised b t if th ari t n was t

thus g ally l mited the process w ul l be trem ly d ffic lt perhaps mpossible [*]

On the Relat n between th Period f De lopmei t f a Cha t r d T ansmiss n to e Sc to both S x s—Why certain char acters l ld be inl rited by botl se s, and othe charact rs b on sex alon nam ly by th t se n wl h tl e h racte first appeared n m t ases q it k wn. We an t

—

n ss, we m

tl m l s l f fam ly and in an tl f m l by tl e f m l al tl gh in botl case transm tted through th pposite as w ll as thro gh th sam se [*] Alth gh w ar th gn ant th two f ll ing rul s see oft t h ld good—that variati wh l first ppear in th r sex t a l t period f l f t l t b de l ped n the sam se l whilst ar ati ns wh h first ppear arly l f in ther sex t nd t b de el ped in botl se es, I am l we far from ppo ng th t th is th sole d t mini g cause. As I h n lsewhere d sc ssed thi bject, and it l as an mportant b ari g on sexual selection I m t h re t i to l gthy and somewl t int cat d tails

It in itself prob bl th t y charact ppear g t an arly ag w ld t d to be inl rited q ally by both se s, f th se d t d ff m ch n const tutio b fore tl pow f reprod t gai ed O the otl er ha d aft tl po l as been gai ed and tl e sexes h com to diff r in co t t t tl

descr b g som ur us cas p geons, I tl

bl h w ry clos ly h uggested th right m thod of procedure.

R fere ces are gi my l riatio f Animal nd Pl nts nder D me ticat n, L p 72.

of the fowl the down covered chickens the young birds in their first true plumage and the adults *differ greatly from one another* as well as from their common parent form the *Gallus bankiva* and these characters are faithfully transmitted by each breed to their offspring at the corresponding periods of life For instance the chickens of spangled Hamburgs whilst covered with down have a few dark spots on the head and rump but are not striped longitudinally as in many other breeds in their *first true plumage* they are beautifully pencilled that is each feather is transversely marked by numerous dark bars but in their

been transmitted to three distinct periods of life The pigeon offers a more remarkable case because the aboriginal parent species does not undergo any change of plumage with advancing age excepting that at maturity the breast becomes more iridescent yet there are breeds which do not acquire their characteristic colours until they have moulted two three or four times and these modifications of plumage are regularly transmitted

Inheritance at corresponding Seasons of the Year —*With animals in a state of nature* innumerable instances occur of characters appearing periodically at different seasons We see this in the horns of the stag and in the fur of arctic animals which becomes thick and white during the winter Many birds acquire bright colours and other decorations during the breeding season alone Pallas states [3] that

marked changes of colour that is from brownish cream-colour or reddish brown to a perfect white in several ponies in England Although I do not know that this tendency to change the colour of the coat during different seasons is *transmitted* yet it *probably* is so as all shades of colour are strongly inherited by the horse Nor is this form of inheritance as limited by the seasons more remarkable than its limitation by age or sex

Inheritance as Limited by Sex —The equal transmission of characters to both sexes is the commonest form of inheritance at least with those animals which do not present strongly marked sexual differences and indeed with many of these But characters are somewhat commonly transferred exclusively to that sex in which they first appear Ample evidence on *this head has been advanced in my work on Variation under Domestication* but a few instances may here be given There are breeds of the sheep and goat in which the horns of the male differ greatly in shape from those of the female and these differences acquired under domestication are regularly transmitted to the same sex As a rule it is the *females alone* in cats which are tortoise shell the corresponding colour in the males being rusty red With most breeds of the fowl the characters proper to each sex are transmitted to the same sex alone So general is this form of transmission that it is an anomaly when variations in certain breeds are transmitted equally to both sexes There are also certain sub breeds of the *fowl in which the males can hardly be distinguished* from one another whilst the females differ considerably in colour The sexes of the pigeon in the parent species do not differ in any external character nevertheless, in certain domesticated breeds the male is coloured differently from the female [36] The wattle in *the English carrier pigeon and the crop* in the pouter are more highly developed in the male than in the female and although these characters have been gained through long continued selection by man the slight differences between the sexes are wholly due to the form of inheritance which has prevailed for *they have arisen not from but rather in opposition to* the wish of the breeder

Most of our domestic races have been formed by the accumulation of many slight variations and as some of the successive steps have been transmitted to one sex alone and some to both sexes, we find in the different breeds of the *same species all gradations between* great

n rs.
m stical n, vol. i. p 51 Also vol. ii p 71 f r a g ner l discussi n on Inh ritance as lim ted by Sex

which the males alone are horned, and also the young of a closely-allied species, the eland (*Oreas*), in which both sexes are horned. Now it is in strict conformity with our rule, that in the young male koodoo, although ten months old, the horns were remarkably small, considering the size ultimately attained by them; whilst in the young male eland, although only three months old, the horns were already very much larger than in the koodoo. It is also a noticeable fact that in the prong-horned antelope only a few of the females, about one in five, have horns, and these are in a rudimentary state, though sometimes above four inches long; so that as far as concerns the possession of horns by the males alone, this species is in an intermediate condition, and the horns do not appear until about five or six months after birth. Therefore in comparison with what little we know of the development of the horns in other antelopes, and from what we do know with respect to the horns of deer, cattle, &c., those of the prong-horned antelope appear at an intermediate period of life,—that is, not very early, as in cattle and sheep, nor very late, as in the larger deer and antelopes. The horns of sheep, goats, and cattle, which are well developed in both sexes, though not quite equal in size, can be felt, or even seen, at birth or soon afterwards. Our rule, however, seems to fail in some breeds of sheep, for instance merinos, in which the rams alone are horned; for I cannot find on enquiry that the horns are developed later in life in this breed than in ordinary sheep in which both sexes are horned. But with domesticated sheep the presence or absence of horns is not a firmly fixed character; for a certain proportion of the merino ewes bear small horns, and some of the rams are hornless; and in most breeds hornless ewes are occasionally produced.

Dr. W. Marshall has lately made a special study of the protuberances so common on the heads of birds, and he comes to the following conclusion:—that with those species in which they are confined to the males, they are developed late in life; whereas with those species in which they are common to the two sexes, they are developed at a very early period. This is certainly a striking confirmation of my two laws of inheritance.

In most of the species of the splendid family of the pheasants, the males differ conspicuously from the females, and they acquire their ornaments at a rather late period of life. The eared pheasant (*Crossoptilon auritum*), however, offers a remarkable exception, for both sexes possess the fine caudal plumes, the large ear-tufts and the crimson velvet about the head; I find that all these characters appear very early in life in accordance with the rule. The adult male can, however, be distinguished from the adult female by the presence of spurs; and conformably with our rule, these do not begin to be developed before the age of six months, as I am assured by Mr. Bartlett, and even at this age the two sexes can hardly be distinguished. The male and female peacock differ conspicuously from each other in almost every part of their plumage, except in the elegant head-crest, which is common to both sexes; and this is developed very early in life, long before the other ornaments, which are confined to the male. The wild-duck offers an analogous case, for the beautiful green speculum on the wings is common to both sexes, though duller and somewhat smaller in the female, and it is developed early in life, whilst the curled tail-feathers and other ornaments of

Antilocapra Americana. I have to thank Dr. Canfield for information with respect to the horns of the female: see also his paper in *Proceedings of the Zoological Society*, 1866, p. 109. Also Owen, *Anatomy of Vertebrates*, vol. iii. p. 627.

I have been assured that the horns of the sheep in North Wales can always be felt, and are sometimes even an inch in length, at birth. Youatt says (*Cattle*, 1834, p. 277) that the prominence of the frontal bone in cattle penetrates the cutis at birth, and that the horny matter is soon formed over it.

I am greatly indebted to Prof. Victor Carus for having made enquiries for me, from the highest authorities, with respect to the merino sheep of Saxony. On the Guinea coast of Africa there is, however, a breed of sheep in which, as with merinos, the rams alone bear horns; and Mr. Winwood Reade informs me that in one case observed by him, a young ram, born on Feb. 10th, first shewed horns on March 6th, so that in this instance, in conformity with rule, the development of the horns occurred at a later period of life than in Welsh sheep, in which both sexes are horned.

'Über die knöchernen Schädelhöcker der Vögel,' in the *Niederländ. Archiv für Zoologie*, Band ...

the latter species they would have been developed earlier in life than in the common peacock; but M. Hegt of Amsterdam informs me that with young birds of the previous year of both species, compared April 23rd, 1869, there was no difference in the development of the spurs. The spurs, however, were as yet represented merely by slight knobs or elevations. I presume that I should have been informed if any difference in the rate of development had been observed subsequently.

gemmules (if I may again use the language of pangenesis) which are cast off from each varying part in the one sex would be much more likely to possess the proper affinities for uniting with the tissues of the same sex and thus becoming developed than with those of the opposite sex

I was first led to infer that a relation of this kind exists from the fact that whenever and in whatever manner the adult male differs from the adult female he differs in the same manner from the young of both sexes The generality of this fact is quite remarkable it holds good with almost all mammals birds amphibians and fishes also with many crustaceans spiders and some few insects such as certain Orthoptera and Libellulæ In all these cases the variations through the accumulation of which the male acquired his proper masculine characters must have occurred at a somewhat late period of life otherwise the young males would have been similarly characterised and conformably with our rule the variations are transmitted to and developed in the adult males alone When on the other hand the adult male closely resembles the young of both sexes (these with rare exceptions being alike) he generally resembles the adult female and in most of these cases the variations through which the young and old acquired their present characters probably occurred according to our rule during youth But there is here room for doubt for characters are sometimes transferred to the offspring at an earlier age than that at which they first appeared in the parents so that the parents may have varied when adult and have transferred their characters to their offspring whilst young There are moreover many animals in which the two sexes closely resemble each other and yet both differ from their young and here the characters of the adults must have been acquired late in life nevertheless these characters in apparent contradiction to our rule are transferred to both sexes We must not however overlook the possibility or even probability of successive variations of the same nature occurring under exposure to similar conditions simultaneously in both sexes at a rather late period of life and in this case the variations would be transferred to the offspring of both sexes at a corresponding late age and there would then be no real contradiction to the rule that variations occurring late in life are transferred exclusively to the sex in which they first appeared This latter rule seems to hold true more generally than the second one namely that variations which occur in either sex early in life tend to be transferred to both sexes As it was obviously impossible even to estimate in how large a number of cases throughout the animal kingdom these two propositions held good it occurred to me to investigate some striking or crucial instances and to rely on the result

An excellent case for investigation is afforded by the deer family In all the species, but one the horns are developed only in the males though certainly transmitted through the female and capable of abnormal development in them In the reindeer on the other hand the female is provided with horn so that in this species the horns ought according to our rule to appear early in life long before the two sexes are mature and have come to

sex alone in which they first appeared in the progenitor of the whole family Now in seven species belonging to distinct sections of the family and inhabiting different regions in which the stags alone bear horns I find that the horns first appear at periods varying from nine months after birth in the roebuck to ten twelve or even more months in the stags of the six other and larger species But with the reindeer the case is widely different for as I hear from Prof Nilsson who kindly made enquiries for me in Lapland the horns appear in the young animals within four or five weeks after birth and at the same time in both sexes So that here we have a structure developed at a most unusually early age in one species of the family and likewise common to both sexes in this one species alone

In several kinds of antelopes only the males are provided with horns whilst in the greater number both sexes bear horns With respect to the period of development Mr Blyth informs me that there was at one time in the Zoological Gardens a young koodoo (*A... strepsiceros*) of

I am m... obliged t... Mr C... ...pl... ... ...ng m... d... ...es f... ...r... ...nl t... ...ll... ...ebuck ...

...ale... f N... Am...rica see *Land* ...d W... ... 1868 pp 221 ... 1254 ... d f... the C... I... *gr...* ...nd C... *st...*

p geon, descr bed by Ne m te ** wh h b th se s ch g tl col r d n g tw r th ee m ult (as l kew e th case w th the lm d t mbl r) n ertheless, these ch g s, th gh occ rring ath r late in l f ar com m to both se s On ar ety of the canary b d nam ly th London P ll s a nearly an l g ase

W th th b eeds of the f wl the nl ntance f ar us charact rs by r b th se seem ally d t m ed by the pe od t l ch h cha acters e d v l ped Tl n all th many b eeds wh ch th ad lt m l d ff s gre tly i colo f m th f mal as ll from th wild pa t p be diff

arly th sam m nn as th pare ts, and

can be maintained

pec l ar black wh t pl m ge wh h l ad to ts t ansf t both sex f the m l l f y t l pec a th black wh t tl f m l b g d ff tly col ured W th th so-c lled Koo sub-b eed f tl f wl l h th f th re t sely pe lled w th d k t p s, b th se es and th ch k l red n ly th sam m nn Th laced pl m g f the Seb ght bantam th sam both se s, and

sembl ach th m l sely than d th se f th abo al p t pec y t th y acq re ther haract n t plum g l t n ld f th f k ns d ti tly pe lled W th pect t tl l aract b d col ur in th ld p t pec d m t f the d m t b eds, tl m l l po sess ll-d l ped comb b t th y g f th Span h f wl l g l d l p d t ry ly g and accordan th th ly d l pm t tl m l t f l ze tl adult f m l I tl g m b eed p g ac t d l ped t w d rf lly ly g

Das G ms der T bens h 1837 ss. 21 F th case of th treaked p geons, see D Ch p is. Le P g Voyageu Belg 1865 p 87

of wl cl cun u proofs could be g en and tl is claract r st s tted to b tl se s so tl t th h n from th e treme pugnac ty re n w g er lly xl b ted n epa ate pe With th Polish breeds th bo s pr t berance of tl e k ll wh h uppo ts tl e st is part ally de el pede nbef etl el i k a l at l ed d the cre t t lf soo beg ns t g ow though t fir t feebly and tl br ed tl ad lt f b th se s ar ch act ised by a gre t bony p otub n e and nme se c e t

F lly f m wh t w ha e n w seen f tl e r lat n wl h ts in many tural specie and d m t ted ac s, b tw en th period f th d el pme t f th r ch acte and tl ma r f th tra m ss n—f r xample th t k g fact f tl e ly growtl of tl e horn the rei dee i wl cl both e s bear h rns in c mp rison w tl th i m l l te gro th in th th pecie n wl h the male l bears h rn —w may co l de tl t th gh t th sol use f characte s b ng l ly l nted by e se n ther d l pm t t lat And seco dly f

It ppears, h w th t som d ff nce mu t m t b twee th se n lum g a ve y arly mb y period f charact s d l ped t tlu g t ar ly becom attached to sex

Summ y d conclud g ema k —Fr m th f g g d sc n atl ar l w f inh ritan w l tl t th ch act s f the pare ts ft n, n g ally tend to be-com d el ped th ff p g f th sam sex, t th ame g d period cally at th sam ason f th ye n wh h they fi t ppeared n the p ts. B t tl se r l s w to kn wn c far f m b g fi ed H n d n g th mod ficat n f pec tl ccess e chang m y ad ly b t an m tl d d ff t y som t o d som to b th som to th ff p g t n g a d som to th ff pri g t ll g N t ly th l w of h tance trem ly complex, but

und th he d f each pec

the male are developed lat as r

u t e characters follow our two rules in their order of development

As most insects emerge from the pupal state in a mature condition it is doubtful whether the period of development can determine the transference of their characters to one or to both sexes But we do not know that the coloured scales for instance in two species of butterflies in one of which the sexes differ in colour whilst in the other they are alike are developed at the same relative age in the cocoon Nor do we know whetl

ars are confin hilst nce not so improbable as it may at first appear for with the Orthoptera which assume their adult state not by a single metamorphosis but by a succession of moults the young males of some species at first resemble the females and acquire their distinctive masculine characters only at a later moult. Strictly analogous cases occur at the successive moults of certain male crustaceans

We have as yet considered the transference of characters relatively to their period of development only in species in a natural state we will now turn to domesticated animals and first touch on monstrosities and diseases The presence of supernumerary digits and the absence of certain phalanges must be determined at an early embryonic period—the tendency to profuse bleeding is at least congenital as is probably colour blindness—yet these peculiarities and other similar ones are often limited in their transmission to one sex

ly th o x s ts full f

cas ccord ng to ur ul W th tl ll d M gu ucullatus w have how r cas f th k nd the t e es d ff r con p cu usly n g n l plum d to a con d r bl d r ee

so that the rule that characters developed at an early period tend to be transmitted to both sexes, here wholly fails But this rule as before remarked does not appear to be nearly so general as the converse one namely that characters which appear late in life in one sex are transmitted exclusively to the same sex From the fact of the above abnormal peculiarities becoming attached to one sex long before the sexual functions are active we may infer that there must be some difference between the sexes at an extremely early age With respect to sexually limited diseases we know too little of the period at which they originate to draw any safe conclusion Gout however seems to fall under our rule for it is generally caused by intemperance during manhood and is transmitted from the father to his sons in a much more marked manner than to his daughters

In the various domestic breeds of sheeps goats and cattle the males differ from their respective females in the shape or development of their horns forehead mane dewlap tail and hump on the shoulders and these peculiarities in accordance with our rule are not fully developed until a rather late period of life The sexes of dogs do not differ except that in certain breeds especially in the Scotch deer hound the male is much larger and heavier than the female and as we shall see in a future chapter the male goes on increasing in size to an unusually late period of life which according to rule will account for his increased size being transmitted to his male offspring alone On the other hand the tortoise shell colour which is confined to female cats, is quite distinct at birth and this case violates the rule There is a breed of pigeons in which the males alone are streaked with black and the streaks can be detected even in the nestlings but they become more conspicuous at each successive moult, so that this case partly opposes and partly supports the rule With the English carrier and pouter pigeons the full development of the wattle and the crop occurs rather late in life and conformably with the rule these characters are transmitted in full perfection to the males alone The following cases perhaps come within the class previously alluded to in which both sexes have varied in the same manner at a rather late period of life and have consequently transferred their new characters to both sexes at a corresponding late period and if so these cases are not opposed to our rule —there exist sub-b ls of the

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p geon, described by N um t r* in wh h both sexes change their col ur duri g tw r three m ults (as i likewise th case with th alm d t mbl) n rth l ss, th se ch g s, th gh occ rrin th l t n l fe are com [redacted] to both sexes. O [redacted] ariety f the canary b rd nam ly th Lond n Prize off [redacted] nearly an l g s case

W th th breeds f th f wl the inh ritance f ario s charact by n or both se s, seem [redacted] n rally d termined by th period at hich ch charact [redacted] e d l ped Thu in all th many breeds n wh ch th ad lt mal diff rs gre tly n colo from th f m l as ll from th wild p t pec es, h diff rs

m t f th breed wh ch the tw se s set l l ach th the y ung are col ed n

l ad t ts transf re ce t both se f th m l al f many t l pe ar the black whit tl f mal b g diff re tly col red W th th so-called hoo b- breed f the f wl wl h th f tl rs are trans sely p lled w th d k tripes, both se and th chi k are col red in ea ly th sam m nn Th laced plum g f th Seb ght bantam th sam both se s, and

sembl ach th m re l sely th d th se f tl bo g al p re t pec y t th y acq th charact r t pl m g l t lf f th h k ns fl li tly pe called W th re pect t th charact rs be d col in th w ld par t spec d m t f th d m t breeds, th m l l possess ll-d l ped comb b t th y g f th Span h f l t larg l d l ped t ry arl ag and accordance w th th arly d l pm t th mal t f us al size tl ad lt f mal I th gam breeds p g ac t d loped t d rf lly ly ag

of wh cl urn u proofs co ld be g a l tl i charact r s t ansm tted to both sex s, so that the h ns, from the trem p gnacity re w g rally h bited in separ t pe s. With th l l sh breeds the bo y protube ance of tl kull which s ppo ts the re t i part lly d lope d e nbef re th l ck ns rel t l ed d th ere t itself soon beg ns to grow th ugh t first feebly * and i thu h ed th ad lt of both se are cha cterised by a gre t bo y prot b ance and an immense c est

F ally from wl t w h n w seen f th rel t n wl h i ts n many n tur l spec e and d me t ted races, between th period f the de l pm nt of their characte s and th man e f th i transmiss n—f r xample the trik g fact f th arly growth of the ll rns tl re ndee i whi cl both se s be r h rns, n comparison w tl th i m cl l te growth in the th r pecie n wl ch th male al e b ars h rn —w m y co l de th t e th gh n t th sol c use f haracte be g d s ly l nited by e se s th r de l pm t at a l t ag And seco dly th t o tho gh pparently l ss ffici t ca se f charact [redacted] be g nherited by both sex s, s th d l pme t t an rly g whilst th se diff but l ttl constit t on. It ppears, h w that some d ffe ce mu t xi t bet een the se n duri g a v y e ly emb period fo haract s d l ped t th t ar ly becom ttached to se

S mm y d lud g ema ks—From th f reg ing disc ss n n th art l w f inh ritance w l arn th t th ch act f th par ts ften, en g ally t nd t be- com d el ped in th off pring f th same sex, t th sam g and period cally t the sam seaso f th y ar wh h th y first ppeared n th parents. B t th se rul s, wi g to unkn wn [redacted] uses, are far from b g fi ed H ce during th mod ficati f pec s, th ccess chang m y ad ly be t ansm tted d ff re t w y som t sex, and some to b th som t th ff p g t n and som t th ff pri t ll g s. N t nly a th laws f inh ritance trem ly compl b t

Das Ganze der T ben. II 1837 ss. 21 24 F the case of th streaked [redacted] geons, see D Chapuis, *Le P g Voyageu Belge*, 1865 p 87

so are the causes which induce and govern variability. The variations thus induced are preserved and accumulated by sexual selection, which is in itself an extremely complex affair, depending, as it does, on the ardour in love, the courage, and the rivalry of the males, as well as on the powers of perception, the taste, and will of the female. Sexual selection will also be largely dominated by natural selection tending towards the general welfare of the species. Hence the manner in which the individuals of either or both sexes have been affected through sexual selection cannot fail to be complex in the highest degree.

When variations occur late in life in one sex, and are transmitted to the same sex at the same age, the other sex and the young are left unmodified. When they occur late in life, but are transmitted to both sexes at the same age, the young alone are left unmodified. Variations, however, may occur at any period of life in one sex or in both, and be transmitted to both sexes at all ages, and then all the individuals of the species are similarly modified. In the following chapters it will be seen that all these cases frequently occur in nature.

Sexual selection can never act on any animal before the age for reproduction arrives. From the great eagerness of the male it has generally acted on this sex and not on the females. The males have thus become provided with weapons for fighting with their rivals, with organs for discovering and securely holding the female, and for exciting or charming her. When the sexes differ in these respects, it is also, as we have seen, an extremely general law that the adult male differs more or less from the young male; and we may conclude from this fact that the successive variations by which the adult male became modified did not generally occur much before the age for reproduction. Whenever some or many of the variations occurred early in life, the young males would partake more or less of the characters of the adult males; and differences of this kind between the old and young males may be observed in many species of animals.

It is probable that young male animals have often tended to vary in a manner which would not only have been of no use to them at an early age, but would have been actually injurious—as by acquiring bright colours, which would render them conspicuous to their enemies, or by acquiring structures, such as great horns, which would expend much vital force in their development. Variations of this kind occurring in the young males would almost certainly be eliminated through natural selection. With the adult and experienced males, on the other hand, the advantages derived from the acquisition of such characters, would more than counterbalance some exposure to danger, and some loss of vital force.

As variations which give to the male a better chance of conquering other males, or of finding, securing, or charming the opposite sex, would, if they happened to arise in the female, be of no service to her, they would not be preserved in her through sexual selection. We have also good evidence with domesticated animals that variations of all kinds are, if not carefully selected, soon lost through intercrossing and accidental deaths. Consequently in a state of nature, if variations of the above kind chanced to arise in the female line, and be transmitted exclusively in this line, they would be extremely liable to be lost. If, however, the females varied and transmitted their newly acquired characters to their offspring of both sexes, the characters which were advantageous to the males would be preserved by them through sexual selection, and the two sexes would in consequence be modified in the same manner, although such characters were of no use to the females: but I shall hereafter have to recur to these more intricate contingencies. Lastly, the females may acquire, and apparently have often acquired by transference, characters from the male sex.

As variations occurring later in life, and transmitted to one sex alone, have incessantly been taken advantage of and accumulated through sexual selection in relation to the reproduction of the species; therefore it appears, at first sight, an unaccountable fact that similar variations have not frequently been accumulated through natural selection, in relation to the ordinary habits of life. If this had occurred, the two sexes would often have been differently modified, for the sake, for instance, of capturing prey or of escaping from danger. Differences of this kind between the two sexes do occasionally occur, especially in the lower classes. But this implies that the two sexes follow different habits in their struggles for existence, which is a rare circumstance with the higher animals. The case, however, is widely different with the reproductive functions, in which respect the sexes necessarily differ. For variations in structure which are related to these functions, have often proved of value to one sex, and from having arisen at a late period

of lif ha been t ansm tted t n sex alo and such ariati s, thus p ese ed and trans mitted ha e gi n rise to seco dary se u l characters.

In th foll wing chapters, I hall treat f the secondary sexual characters in animals f all classes, and shall e d a ur in each case t pply th pri ciples plai ed n tl prese t ch pte Th l w st classes w ll d tain u f rv sh rt tim b t tl higl animals, pe- ciall birds, m t be tre ted at consid able l gth It h ld be b rn m d that f r

w th most intere ti g

Supplement on the proportional numbers of the two sexes in an mals belonging to various classes

As n e, as far as I can d sco e has paid att t to th rel ti n mb rs f th tu se thro gh t th animal kingd m I will h re gi such m terial as I h been abl to collect, alth gh th y are t m ly imperfect. Th consist in only f w instance f actual um ti n, and th numb rs are n t ry larg As th proporti ns are kn wn w th ce tainty nly n manki d I will first gi e th m as tandard of comparison.

M n.—I E gland during ten y ars (from 1857 to 1866) th er g numb r of children born ali y arly was 07 1 0 in th propo t f 104.5 mal t 100 f mal s. B t in 1857 the male b rths thro gh t E gland w re as 105 2, and 186 as 104 0 t 100 Looki g t separate d tricts, in B cki ghamshire (wh re abo t 000 childre are ann ally born) th me proporti f mal to f mal births, d g th wh l period f th abo t n y ars, was as 102 8 to 100 wh lst N Wales (wh re th ag annual b rths are 12,8 3) t was as high as 106 to 100 Taki g till mall dis- trict, z. R tlandshire (wh re th ann al b rths ag nly 39) 1864 th mal b rths w re as 114 6 and in 1862 as nly 97 0 t 100 b t in this small distri t th g f th 385 b rths d ri g th wh l years, was as 104.5 to 100 that n th sam

100 but during this pe ... times in departme t, and six time in another that the female b rth l exceeded th mal s. In Russia tl e a erage propo t n is as high as 108 9 and in P hilad lph a n tl e United State as 110.5 to 100 The a r g f Europe deduced by Bicke from abo t se ty mill n b ths, is 106 males to 100 f mal s. On th othe l nd w th wh t cl ldren born at tl C pe of Good Hope, the propo ti f males is so low as t fl t te luring ccessi y ars between 90 and 99 males f r e ry 100 f mal s. It is si gular fact tl t w th Jews the proporti n f male births s decidedly larg than with Christian th s Prussia tl propo t on is as 113 Breslau as 114 and in L m as 120 to 100 th Chris- tian b rths these countri s be ng tl sam as usual fo nstance in L onia as 104 to 100 [a]

Prof F y e remarks that a till greate pre- po d rance of males would be n t w th if d th truck both se es in eq al proporti n in th w mb and duri g b rth. But the fact is, th t f ry 100 till born f males, w ha n se ral countri from 134 6 to 144 9 till born males. During tl first f ur r fi e y ars f life also, m re m le ch ldren d e than fe- mal s, f r example n England d ring th first y ar 126 boys d f r ry 100 gi ls—a pro- po ti n which n F ance is t ll m re unfa abl D Stockt H gh accou ts for

P oductio de S xe 1863 p 25

British nd Foreig Medico-Ch g Review April 1867 p. 343 D St k lso rem (*T nth Ann al Reports f B rths D ath d nd* 1867 p. xx ii.) that "These amples m y uffice t sh w th t, t lmost ry tag of life, th males Scotla d h greate liability to death d

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i jui ous But the size of the body and e peci ally of the head being greater in male than female infants is another cause for the males are thus more liable to be injured during parturition Consequently the still born males are more numerous and as a highly competent judge Dr Crichton Browne believes male infants often suffer in health for some years after birth Owing to this excess in the death rate of male children both at birth and for some time subsequently and owing to the exposure of grown men to various dangers and to their tendency to emigrate the females in all old settled countries where statistical records have been kept are fo ... der

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and climates in Naples Prussia, Westphalia, Holland France England and the United States the excess of male over female births is less when they are illegitimate than when legitimate This has been explained by different writers in many different ways as from the mothers being generally young from the large proportion of first pregnancie &c But we have seen that male infants from the large size of their head suffer more than female infants during parturition and as the mothers of illegitimate children must be more liable than other women to undergo bad labours, from various causes such as attempts at concealment by tight lacing hard work distress of

high r d ath t th n th fem l s The f ct how e e f thi ... cul ar ty b g m t stro gly de- v l ped t th t if it l p od of l f wl i th d ss food d g i al treatm nt f b th e re l k s m t pro that the higl r male de th r t i mp ssed n tur l a d con tit t n l pecul ty d t s l n

mate With most animals the greater size of the adult male than of the female is due to the stronger males having conquered the weaker in their struggles for the possession of the females, and no doubt it is owing to this fact that the two sexes of at least some animals differ in size at birth Thus we have the curious fact that we may attribute the more frequent deaths of male than female infants especially amongst the illegitimate at least in part to sexual selection

It has often been suppo ed that the relative age of the two parents determine the sex of the off pring and Prof Leuckart[a] has advanced what he con iders sufficient evidence with respect to man and certain domesticated animal that this is one important though not the sole factor in the result So again the period of impregnation relatively to the state of the female has been thought by some to be the efficient cause but recent observations discountenance this belief According to Dr Stockton Hough[b] the season of the year the poverty or wealth of the parents residence in the country or in cities the crossing of foreign immigrants &c all influence the proportion of the sexes. With mankind polygamy has also been suppo ed to lead to the birth of a greater proportion of female fa ...

as from monogamous unions Hardly any animal has been rendered so highly polygamous as the English race hor e and we shall immediately see that his male and female off pring are almost exactly equal in number I will now give the facts which I have collected with respect to the proportional numbers of the sexes of various anim als and will then briefly discu s how far selection has come into play in determining the re ult

Ho s s —Mr Teg tmeier has been so kind as to tabulate for me from the *Racing Calendar* the births of race horses during a period of twenty one years, viz from 1846 to 186 1849 being omitted as no returns were that

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[a] Le ck rt i W b *H ndwo terbuch der Phys.* B 1853 s. 774
[b] *Soc al Sci nc ... l soc at ... f Ph l d lph* 1874.
[c] *Anth polog al Review* April, 18 0 p cviii.

y ar p blished The total b ths we ... 360 ... consist g f 1 63 mal and 1 97 fem l s, in the propo ti n f 99 mal s t 100 females. As these n mbe s ar t l bly larg and as th y are drawn from ll parts f E g land, during se al y ... may w th m ch ... th t w tl the dom tic

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lated are cons d red ... ho ses w as 10 1 ... in 1867 as ... to 1 ... tab lated ... proj ... cret ... and th f mal ... periods ach ... y ars th ... be acc d tal t l ast I can d tect th g f th kind with man in th decenni l t bl th *Registrar s Report f 1866*

D g —During period of tw l rs, from 1857 to 1868 th b th f l g n ml f grey) unds thro gh t E gland w re se t t th *F ld* w p pe d I m gar d bted to M T g tm e f caref lly t b la ting th ults. Th ecorded b rth re 68 8 cons ti g f 360 mal and 3 3 f m l s, th t s, in tl proport f 110 1 m l to 100 f m l Th gre t t fl t t ns occurred

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astr ted so th t tl e f llo ing returns d n t ... tl e propo t ons t bi tl M co c I fnd th t se al g t breed ... n Scotla l wl o ... ti ar l leep e f n l

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heep ch fly Le ce t ra, d ring ... to xteen y ars th y am unt all ... tl r t 896 b rths, co sisti g of 4407 mal and 4 8 femal th t i in th propo ti n of 96 7 m l s t 100 f m l s. W th re pect t Cl evi t and black faced heep b ed in Scotland I l a e rece ed returns from ix breed s, tw f tl e n n larg scal chi fly f th year 186 1869 b t some f the ret rn t d back t 1862 The total n mb r recorded amo nts to 0 685 cons ti g f 071 m les nd 25 614 fen ales r n th proport on f 97 9 males to 100 f mal s. If w take the E gl sh and Scot h t n st g th r th t tal n mber am ts t 9 650 consisti g f 29 4 8 mal s and 30 172 f m l s, as 97 7 t 100 So th t with heep f t t the f mal s are ce

th se con is cu ... al n the proport f 94 4 mal t 100 f m l Th R W D F nf rms me that n 1867 t f 34 cal born f rm n D bysh nly was b ll. M Har so W has q red from se al b eed s f *I g* and m t f th m t mat th mal to th f mal b rth as b t t ... Th same

comm n t, I h rece ed co fl ting t t

I m m ch d bted t M C pples f h g procured f m th bo ... from Scotl d as ll som f th f llo g retur catt) M R. Ell t, f La gh ood first called my tt t t th prem ture d this f th males,— tat m t b que tly confi med by M A tchiso d th rs. T tl s I tt g tl m d t M ... yan I my thanks f larg returns as t heep

f m les ere bo n, and 794 mares f led.

ments Mr R Elliot of Laighwood informs me that a rat catcher assured him that he had always found the males in great excess even with the young in the nest In consequence of this Mr Elliot himself subsequently examined some hundred old ones and found the statement true Mr F Buckland has bred a large number of white rats and he also believes that the males greatly exceed the females In regard to moles it is said that the males are much more numerous than the females [60] and as the catching of these animals is a special occupation the statement may perhaps be trusted Sir A Smith in describing an antelope of S Africa[61] (*Kobus ellipsiprymnus*) remarks that in the herds of this and other species the males are few in number compared with the females the natives believe that they are born in this proportion others believe that the younger males are expelled from the herds and Sir A Smith says that though he has himself never seen herds consisting of young males alone others affirm that this does occur It appears probable that the young when expelled from the herd would often fall a prey to the many beasts of prey of the country

Birds

With respect to the *Fowl* I have received only one account namely that out of 1001 chickens of a highly bred stock of Cochins, reared during eight years by Mr Stretch 487 proved males and 514 females i e as 94 7 to 100 In regard to domestic pigeons there is good evidence either that the males are produced in excess or that they live longer for these birds invariably pair and single males as Mr Tegetmeier informs me can always be purchased cheaper than females Usually the two birds reared from the two eggs laid in the same nest are a male and a female but Mr Harrison Weir who has been so large a breeder says that he has often bred two cocks from the same nest and seldom two hens moreover the hen is generally the weaker of the two and more liable to perish

With respect to birds in a state of nature Mr Gould and others are convinced that the males are generally the more numerous and as the young males of many species resemble the females the latter would naturally appear to be the more numerous Large numbers of pheasants are reared by Mr Baker of Leadenhall from eggs laid by wild birds and he informs Mr Jenner Weir that four or five males to one female are generally produced An experienced observer remarks[62] that in Scandinavia the broods of the capercailzie and black cock contain more males than females and that with the Dal ripa (a kind of ptarmigan) more males than females attend the *leks* or places of courtship but this latter circumstance is accounted for by some observers by a greater number of hen birds being killed by vermin From various

and I have been assured that this is the case in Scotland Mr Weir on enquiring from the dealers who receive at certain seasons large numbers of ruffs (*Machetes pugnax*) was told that the males are much the more numerous. This same naturalist has also enquired for me from the birdcatchers who annually catch an astonishing number of various small species alive for the London market and he was unhesitatingly answered by an old and trustworthy man that with the chaffinch the males are in large excess he thought as high as 2 males to 1 female or at least as high as to 3[63] The males of the blackbird he likewise maintained were by far the more numerous, whether caught by traps or by netting at night These statements may apparently be trusted because this same man said that the

net the females preponderate greatly but unequally during different years during some years he has found the females to the males as four to one It should however be borne in mind that the chief season for catching birds does not begin till September so that with some species partial migrations may have begun and the flocks at this period often consist of hens alone Mr Salvin paid particular attention to the sexes of the humming birds in

[60] B ll, *H to y f British Q druped* p 100
Ill t t ons f the Zool gy f S Afr 1849 pl 29

[61] Br hm (*Illust t T l ben* B iv s. 990) comes t the sam conclus n

[62] On th th r ty f L Lloyd *G me B rds f Swed* 1867 pp 12 132

[63] *N t H t f S lbo ne* l tt xxi ed of 1825

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Ce tral Am rı a, and s con inced th t with most of th pecies th m les are n cess thus ar he proc red 04 pecim ns belonging t t pecies, and these consisted of 166 mal and f only 38 f m l s. W th two th r species th f mal were ı xcess b t tl proport ns pparentl tl r durı g diff re t seasons l ffe t local t es f occası th mal f *Campylopt rus hem leucurus* w t th f m les as t 2 and an th occas n e actly th re rsed ratio. As bearing n thı latte po nt, I may add that Mr P w f und ı Co fu and Epirus the se es f tl ch ffinch keep ng part, and th f m l b far th mo t nu m rous whilst ı l al tı M Trıst am f nd th male flocks ppearıng gre tly to ceed th fem l mbe So gaı with th *Q ıs alus maj* M G T l says, th t *Fl rıd tl re w re ry l w f m les* propo tı t th mal s, whılst H n d as the p portı was tl th w the pecies th re h g th ha act f polyga mı t.

Fish

are many difficult ın a rı g t any just co lusı Inf rt l f m l m ght read ly be mıstak f males, as D Gü the has re marked to m n regard t tro t W th some pecı th mal are b h ed t dı soon aft r f tılısı g th a. W tl many pecı th m les are f mu h mall tl n th females, so tl t larg umbe f mal wo ld scape from th sam t b wh h tl f m l w re ght. M C bonn wh has specı ally ttended to th n t al hı t y f th pık (*Es lucius*) t tes th t many mal s, wı g t th ır mall ız are d red by the larg f mal and h belı th t th m les of alm t all fish re posed from thıs sam se to greate dang than th f males. N rth l ss, ın tl f w cases ın wl ca th proportı al mbers h bee t ally b se ed th mal ppe t be larg l ın e

cess. Tl s Mr H Bu t, th upernt nde t of t tfi l l xperım nts, sa s tl at ın l l ı

female Afterward females ufficıe t ı r btaining a were procured He adds, from th great proportı n of the mal s, th y are con tantly fightıng and tearı g eacl th r n tl e pawnıng beds. Thus dı propı l no d ubt, can be accounted fo n part, b t wl ther wholly ıs d ubtf l by the males ascend g th m ers before the females. Mr F B kland remarks ın reg rd t trout, that t s a curı us fact th t the males preponde te y larg ly ı mb o r th females. It *arıably* l p-

mal s to e q te account f tl tl r tl males are m re num rous than tl e f m les, tl l tt r seek saf ty by concealm t th than fl gl t H U n adds, tl t by c ref lly searcl g th banks uffici t f mal s for btaını g o a an be f und Mr H Lee af rus m th t o t of 212 tro t tak n f thı purpose ın Lord P tsm uth s park, 1 0 w re mal and 6 f m les.

Th males of the Cyprinidæ lık wise seem to be ın cess b t se al m mbers *f thıs f* m ily ız th arp tench bream and m nn w ppear reg larly to f ll w the p actice rare ın th anımal kı gd m of pol andry fo the f mal whilst sp wnıng al ys att nded by tw males ach sıd and the ase f the bream by three r f ur mal s. Th fact ıs so w ll k wn th t t alw y recomm nded t tock pond w th tw male t ches t ne f male, r t l ast w th three males to tw fe mal s. W th th m nn w an cell t bser e tat s, th t n th spa nı g bed th mal are ten tım s as num ro s as tl f m l wl n f mal com m t th mal s, h mmed t ly pressed lo ly by mal ach sıd and wh th y h been n tl t t f a tım are perseded by the tw m l s.

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In this great class the Lepidoptera almost alone affords means for judging of the proportional numbers of the sexes for they have been collected with special care by many good observers and have been largely bred from the egg or caterpillar state I had hoped that some breeders of silk moths might have kept an exact record but after writing to France and Italy and consulting various treatises I can not find that this has ever been done The general opinion appears to be that the sexes are nearly equal but in Italy as I hear from Professor Canestrini many breeders are convinced that the females are produced in excess This same naturalist however informs me that in the two yearly broods of the ailanthus silk moth (*Bombyx cynthia*) the males greatly preponderate in the first whilst in the second the two sexes are nearly equal or the females rather in excess

In regard to butterflies in a state of nature several observers have been much struck by the apparently enormous preponderance of the males[74] Thus Mr Bates[75] in peaking of several pecies about a hundred in number which inhabit the upper Amazons says that the males are much more numerous than the females even in the proportion of a hundred to one In North America Edwards who had great experience estimates in the genus Papilio the males to the females as four to one and Mr Walsh who informs me of this statement says that with *P turnus* this is certainly the case In South Africa Mr R Trimen found the males in excess in 19 species[76] and in one of these which swarms in open places he estimated the number of males as fifty to one female With another pecies in which the males are numerous in certain localities he collected only five females during seven years In the islan l of Bourbon M Maillard states that the males of one species of Papilio are twenty times as numerous as the females[77] Mr Trimen informs me that as far as he has himself seen or heard from others it is rare for the females of any butterfly to exceed the males in number but three South African pecies perhaps offer an exception Mr Wallace[79] states that the females of *Ornithoptera crœsus* in the Malay Archipelago are more common an l more easily caught than the males but this is a rare butterfly I may here add that in Hyperythra, a genus of moths Guenée says, that from four to five females are sent in collections from India for one male

it was generally admitted that the males of most Lepidoptera, in the adult or imago state are caught in greater numbers than the females but this fact was attributed by various observers to the more retiring habits of the females and to the males emerging earlier from the cocoon This latter circumstance is well known to occur with most Lepidoptera as well as with other insects So that as M Personnat remarks the males of the domesticated *Bombyx yamamai* are useless at the beginning of the season and the females at the end from the want of mates.[80] I cannot however persuade myself that these causes suffice to explain the great excess of males in the above cases of certain butterflies which are extremely common in their native countries Mr Stainton who has paid very close attention during many years to the smaller moths informs me that when he collected them in the imago state he thought that the males were ten times as numerous as the females but that since he has reared them on a large scale from the caterpillar state he is convinced that the females are the more numerous Several entomologists concur in this view Mr Doubleday however and some others take an opposite view and are convinced that they have reared from the eggs and caterpillars a larger proportion of males than of females

Besides the more active habits of the males their earlier emergence from the cocoon and in some cases their frequenting more open stations other cau es may be a igned for an apparent or real difference in the pr portional num bers of the sex s of Lepidopt ra, when captu ed in the imago tate and when reared from the egg or caterpillar tate I hear from Profe or Cane trini that it is believed by

[74] Leuckart qu te M ck (W g r H nd wo t b h d Phy B 1853 75) that the m l f b tt fl re three four t s as numerous as th f males.

[75] *Th N t al t n th Amazons* v l i 1863 pp 228 347

[76] F u f thes ase are g n by Mr T me in his *Rhopalocer Afri æ* *Aust alis*

[77] Quoted by Trim T *act ns f th Ent. Society* v l v part iv 1866 p 330

[78] *T art I n Society* l x p 37

I oc d g I to ological Society I B 17 1868

[80] Q ted by Dr W llace n *I oc d g Ent mological Society* 3rd se es, v l 1867 p 487

many breed rs in Italy that th f mal t r pilar of th silk m th ff rs m re from th rece t disease than th male and Dr Sta dinge inf rms m th t in rearing Lep d pt ra — l l th cocoon than mal s.

males. — —
was then practice b t D Wallace is re t collect rs t k all th pecim ns

abl d ur th largest and Professor Can strini inf rms m th t in Italy some breed rs beli e, tho gh n ns ffici d nce that in th first broods f th ailanthus s lkm th, th wasps destro larg numb of the female than of th mal cat rp llars. D Wallace furth remarks th t f mal caterpillars, from being larg than th males, require m re tim for their d l pm t, and consum m re food and moisture and thu th would be xposed d rin longer tim to dan er from ichneu mons, birds, &c., and tim l scarcity w uld perish in greate numbers. Hence t ppears quite possible that in tate of nature, f w f mal Lep d pt ra may reach maturity than males and f pecial bject w are concerned with th ir relati numbers t m t nt wh n th se es are read to propag t the kind

ce of th male from th ir cocoons. Mr tainto inf rms m that from tw l to tw males, may often be seen co gre ted ro nd f male *Elachista rufocinerea*. It well known that if virgin *Lasiocampa quercus* Sat rn carpi be exposed in a cage ast umbers f males collect round h and if confined room will com d wn th chim ne t he Mr D bled beli es that h has see from fift t h ndred males of both these peci attracted in th course f si gle d b femal in confin m t. I th I le f Wight Mr Trimen xposed a bo wh h f mal of th Lasiocamp had bee confi ed th pre us da and fi males soo n d vored gain admittance I A stralia, Mr V rreaux, ha ing placed th f male of a small Bomb x in a bo n l pocket, was f l lowed l crowd f males, so that about 200 ent

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entl nd t s tl t rsel th mal ceed th f mal in th sam proporti n. About 000 pecies r ari ti s f m th (Het rocera) are cat l gued th se th w l m f males bein, here e l ded n acco f th d ff r nce habi t between the tw se f th se 000 pecies, 141 d ff in price acc rd g to sex, the mal f 1 0 be cl eape f those f nly 11 be g d re th an th f m les. Th ra price of th m l f th 1 0 pecies, to th t f the f males, as 100 to 143 W th re pect t th b tt flies n this priced l t, M D bled thinks (and no man n E gland

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an xcess in th numbe of th mal s. B t I am

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and th arli m rge ce of th males w ll acco nt f his collectors secur lar r numbe f males than f f males, and consequ tly f th lower prices f the form W th respect t specimens reared from th cat pillar tate, Dr Sta ding beli es, as pre ousl tated th t great r numbe f f males than f males d while t confined to th cocoons. H adds th t with certain peci one sex seems to prepond rate o th th during certain ars.

Of direct bserv ti ns n th sexes of Lep dopt ra, reared th from gg cat rp llars, I ha rece ed nly th f w f ll wi g case —

So that n th se ht l t of cocoons and ggs, males w re prod ced n xcess. T n to th th proporti n f mal is as 1 t

Bla chard, *Met morphoses, Mœu de Insectes*, 1868, pp 225–26

Lepid pteren Do bletten Liste Berlin, No. 1866

See table page 390

INSECTS

In this great class the Lepidoptera almost alone affords means for judging of the proportional numbers of the sexes, for they have been collected with special care by many good observers, and have been largely bred from the egg or caterpillar state. I had hoped that some breeders of silk moths might have kept an exact record, but after writing to France and Italy, and consulting various treatises, I cannot find that this has ever been done. The general opinion appears to be that the sexes are nearly equal, but in Italy, as I hear from Professor Canestrini, many breeders are convinced that the females are produced in excess. This same naturalist, however, informs me that in the two yearly broods of the ailanthus silk moth (*Bombyx cynthia*) the males greatly preponderate in the first, whilst in the second the two sexes are nearly equal, or the females rather in excess.

In regard to butterflies in a state of nature several observers have been much struck by the apparently enormous preponderance of the males.[74] Thus Mr. Bates,[75] in speaking of several species, about a hundred in number, which inhabit the upper Amazons, says that the males are much more numerous than the females, even in the proportion of a hundred to one. In North America, Edwards, who had great experience, estimates in the genus Papilio the males to the females as four to one; and Mr. Walsh, who informs me of this statement, says that with *P. turnus* this is certainly the case. In South Africa, Mr. R. Trimen found the males in excess in 19 species;[76] and in one of these, which swarms in open places, he estimated the number of males as fifty to one female. With another species, in which the males are numerous in certain localities, he collected only five females during seven years. In the island of Bourbon, M. Maillard states that the males of one species of Papilio are twenty times as numerous as the females.[77] Mr. Trimen informs me that as far as he has himself seen, or heard from others, it is rare for the females of any butterfly to exceed the males in number; but three South African species perhaps offer an exception. Mr. Wallace[78] states that the females of *Ornithoptera crœsus*, in the Malay Archipelago, are more common and more easily caught than the males; but this is a rare butterfly. I may here add that in Hyperythra, a genus of moths, Guenée says, that from four to five females are sent in collections from India for one male.

When this subject of the proportional numbers of the sexes of insects was brought before the Entomological Society,[79] it was generally admitted that the males of most Lepidoptera, in the adult or imago state, are caught in greater numbers than the females; but this fact was attributed by various observers to the more retiring habits of the females, and to the males emerging earlier from the cocoon. This latter circumstance is well known to occur with most Lepidoptera, as well as with other insects. So that, as M. Personnat remarks, the males of the domesticated *Bombyx yamamai* are useless at the beginning of the season, and the females at the end, from the want of mates.[80] I cannot, however, persuade myself that these causes suffice to explain the great excess of males, in the above cases of certain butterflies which are extremely common in their native countries. Mr. Stainton, who has paid very close attention during many years to the smaller moths, informs me that when he collected them in the imago state he thought that the males were ten times as numerous as the females, but that since he has reared them on a large scale from the caterpillar state he is convinced that the females are the more numerous. Several entomologists concur in this view. Mr. Doubleday, however, and some others, take an opposite view, and are convinced that they have reared from the eggs and caterpillars a larger proportion of males than of females.

Besides the more active habits of the males, their earlier emergence from the cocoon, and in some cases their frequenting more open stations, other causes may be assigned for an apparent or real difference in the proportional numbers of the sexes of Lepidoptera, when captured in the imago state, and when reared from the egg or caterpillar state. I hear from Professor Canestrini, that it is believed by

[74] Leuckart quotes Meinecke (Wagner, *Handwörterbuch der Phys.*, B. iv, 1853, s. 775) that the males of butterflies are three or four times as numerous as the females.

[75] *The Naturalist on the Amazons*, vol. ii, 1863, pp. 228, 347.

[76] Four of these cases are given by Mr. Trimen in his *Rhopalocera Africæ Australis*.

[77] Quoted by Trimen, *Transactions of the Ent. Society*, vol. v, part iv, 1866, p. 330.

[78] *Transactions of the Linnean Society*, vol. xxv, p. 37.

[79] *Proceedings of the Entomological Society*, Feb. 17, 1868.

[80] Quoted by Dr. Wallace in *Proceedings of the Entomological Society*, 3rd series, vol. v, 1867, p. 487.

ferent localities. But as H. Müller has himself remarked to me, these remarks must be received with some caution, as one sex might more easily escape observation than the other. Thus his brother Fritz Müller has noticed in Brazil that the two sexes of the same species of bee sometimes frequent different kinds of flowers. With respect to the Orthoptera, I know hardly anything about the relative number of the sexes: Korte, however, says that out of 500 locusts which he examined, the males were to the females as five to six. With the Neuroptera, Mr. Walsh states that in many but by no means in all the species of the odonatous group, there is a great overplus of males: in the genus Hetaerina, also, the males are generally at least four times as numerous as the females. In certain species in the genus Gomphus the males are equally in excess, whilst in two other species, the females are twice or thrice as numerous as the males. In some European species of Psocus thousands of females may be collected without a single male, whilst with other species of the same genus both sexes are common.[39] In England, Mr. MacLachlan has captured hundreds of the female Apatania muliebris, but has never seen the male; and of Boreus hyemalis only four or five males have been seen here.[40] With most of these species (excepting the Tenthredinae) there is at present no evidence that the females are subject to parthenogenesis; and thus we see how ignorant we are of the causes of the apparent discrepancy in the proportion

which is sometimes carried to an extreme degree) and their widely different appearance may account in some instances for their rarity in collections.[43]

Some of the lower crustaceans are able to propagate their kind sexually and this will account for the extreme rarity of the males: thus von Siebold carefully examined no less than 13,000 specimens of Apus from twenty-one localities, and amongst these he found only 319 males. With some other forms (as Tanais and Cypris), as Fritz Müller informs me, there is reason to believe that the males are much shorter-lived than the females; and this would explain their scarcity, supposing the two sexes to be at first equal in number. On the other hand, Müller has invariably taken far more males than females of the Diastylidae and of Cypridina on the shores of Brazil: thus with a species in the latter genus, 63 specimens caught the same day included 57 males; but he suggests that this preponderance may be due to some unknown difference in the habits of the two sexes. With one of the higher Brazilian crabs, namely a Gelasimus, Fritz Müller found the males to be more numerous than the females. According to the large experience of Mr. C. Spence Bate, the reverse seems to be the case with six common British crabs, the names of which he has given me.

The proportion of the sexes in relation to natural selection

There is reason to suspect that in some cases man has by selection indirectly influenced his own sex-producing powers. Certain women no doubt tend to produce during their whole lives more children of one sex than of the other: and the same holds good of many animals, for in-

...tended to this class during many years, writes to me that the males from their more erratic habits are more commonly seen, and therefore appear more numerous. This is actually the case with a few species, but there are many exceptions: several species in six genera, in which the females appear to be much more numerous than the males.[42] The small size of the males in comparison with the females (a peculiarity

Die Sirach, Zug oder Wanderheuschrecke, 1828, p. 20.

[39] Observations on N. American Neuroptera, by H. Hagen and B. D. Walsh, Proceed. Ent. Soc. Philadelphia, Oct., 1863, pp. 168, 223, 239.

[40] Proceedings, Ent. Soc. London, Feb. 17, 1868.

[41] Another great authority with respect to this class, Prof. Thorell of Upsala (On European Spiders, 1869-70, part i., p. 205), speaks as if female spiders were generally commoner than the males.

stance, cows and horses, produced several fillies. Though I have very little evidence on this head, analogy would lead to the belief that the tendency to produce either sex would be inherited like almost every other peculiarity, for instance that of producing twins; and concerning the above tendency a good authority, Mr. J. Downing, has communicated to me facts which seem to prove that this does occur in certain families of short-horn cattle. Col.

[42] See, on this subject, Mr. O. P. Cambridge, as quoted in Quarterly Journal of Science, 1868, page 429.

[43] Beiträge zur Parthenogenesis, p. 174.

100 females But the numbers are hardly large enough to be trustworthy

On the whole from these various sources of evidence all pointing in the same direction I infer that with most species of Lepidoptera the mature males generally exceed the females in number whatever the proportions may be at their first emergence from the egg

	Male	F male
The Rev J H ll [54] of Exeter reared dur ng 1868 im gos of 73 speci s b ch co i t d of	153	137
Mr Alb rt J nes of Elth n reared durn g 1868 imagos of 9 pec es w hich con sted f	159	126
Dur ng 1869 I reared magos f om 4 species co isti g f	114	112
Mr Buckler of E m rth Hants during 1869 reared im gos from 74 peci c ns sting of	180	169
Dr Wallace of C lchester reared from one brood f *Bombyx cynthia*	2	48
Dr Wall r sed fr m cocoons of *Bombyx pernyi* ent from Ch n during 1869	[illegible]	[illegible]
Dr W llace raised du i g 1868 a l 1869 from two lots of coc ns of *B mbyx ya ian a*	2	46
Total	934	61

It is hardly worth while saying anything about the proportion of the sexes in certain species and even groups of insects, for the males are unknown or very rare and the females are parthenogenetic that is fertile without sexual union examples of this are afforded by several of the Cynipidæ [55] In all the gall making Cynipidæ known to Mr Walsh the females are four or five times as numerous as the male and so it is as he informs me with the gall making Cecidomyiidæ (Diptera) With some common species of saw flies (Tenthredinæ) Mr F Smith has reared hundreds of specimens from larvæ of all sizes, but has never reared a single male on the other hand Curtis says [56] that with certain species (Athalia) bred by him the males were to the females as six to one whilst exactly the reverse occurred with the mature insects of the same species caught in the fields In the family of bees Hermann Müller collected a large number of specimens of many species and reared others from the cocoons and counted the sexes He found that the males of some species greatly exceeded the females in number in others the reverse occurred and in others the two sexes were nearly equal But as in most cases the males emerge from the cocoons before the females they are at the commencement of the breeding season practically in excess Müller also observed that the relative number of the two sexes in some species differed much in different

With reference to the other Orders of insects I have been able to collect very little reliable information With the stag beetle (*Lucanus cervus*) the males appear to be much more numerous than the females but when as Cornelius remarked during 1867 an unusual number of these beetles appeared in one part of Germany the females appeared to exceed the males as six to one With one of the Elateridæ the males are said to be much more numerous than the females and two or three are often found united with one female [53] so that here polyandry seems to prevail With Siagonium (Staphylinidæ) in which the males are furnished with horns the females are far more numerou than the opposite sex Mr Janson stated at the Entomological Society that the females of the bark feeding *Tomicus villosus* are so common as to be a plague whilst the males are so rare as to be hardly known

were estim te that I f i t i poss bl to ta late th m.

[53] Gunth r *Reco d of Zoolog al I t tur* 1867

[54] W lsh i the *Am ri Entomol gi t* I. i 1869 p 103 F S ith *R d f Zoolog l Lit* 1867 p 328

[55] *I f ect* ii 45-46

[56] An d g I D rwinsch n Lehre" *Verh. d. n. V J l g*

we ha un — —
males.

In cens s f all th ı la d ın 18 0[88] th males of all ages am unt to 36 2 2 and th f mal to 33 128 as 109 49 to 100 Th males und se tee y ars am unted to III 3 and th f mal und the ame ag to 9 93 as 112.3 to 100 F m the census f 18 2 th proporti n f m l f all ge (cl ding half-castes) to f mal s, ıs as 125.36 t 100 It must b b rn n mind th t all th se t ns f tl Sand ch I land tl pro-port f l p m l to l g f mal s, and

ref rred t b rths[89]

[88]Th g ın th R H. T Cheever L f

the reclaimed nati es, w may uspect that, as th

breeds, th the cepti n, pe haps, of greyh ds, ma y more f mal p pp es re destroyed th males, just as th th Tod nf ts. M C pples

From tl e se eral f reg ıng cases we have som eason t b l e tl at nfant de p ac t ed th manne above explained tends to

pecı s, has been tl sol d t rmını g c se an excess f m l s. Tl ere may be some un known l w l ad g to thı result decreası g races, which l a e al eady becom somewh t unf rtıle Be des the se ral causes p ı usly all ded t th g ter facıl ty of parturition am gst sa ages, and tl e l ss consequent ınj y t ther mal ınfants, wo ld te d to ıncrease th proport on of l ı e-born mal s to females. Th re does not, l seem to be any necessary connecti n b t een savage l fe and marked cess f male tl at ıs ıf we m y judg by the haracter f tl e scanty ff

As the mal s and f mal s f many anımals d ff som wh t l bits and ar e posed ın diff rent d gree to dang r ıt s probable that n many cases, m re f n sex tl an f the oth r are hab tually destroyed II t as f as I

p od cı g pow f tl pecı s W th strı tly social anımals, ch as bee r ants, which pro-d ce a vast umb f st rıle and fert l fe-mal compar son with the mal s, and to wl m thı prepo derance ıs f param ı mpo tance w an see that th se commu tı w uld fl urısh b t wh h co taı ed fe-mal h g a tro g ınh ted te d ncy to prod ce m re and m f m l s and ın ch cas an equal se prod g tend cv w ld be ultım t ly gaı ed th gh nat l select W th anım ls l g ın h rd troops, a which th mal come to tl fro ı and d f d th h rd as w th th bıson f N rth Ame ca and certaın b boo s, t co ce III th t m l prod g t d cy mıght b gaıned by n tu al select n f tl ınd d ls f tl b tt d f ded h d w ld l m m us d se dants, In th case f mankı d th ad t g rı g f m h g a prepo d ce f m ın th tr be p-

Marshall[94] has recently found on careful examination that the Todas, a hill tribe of India, consist of 112 males and 84 females of all ages—that is in a ratio of 133.3 males to 100 females. The Todas, who are polyandrous in their marriages, during former times invariably practised female infanticide; but this practice has now been discontinued for a considerable period. Of the children born within late years the males are more numerous than the females, in the proportion of 124 to 100. Colonel Marshall accounts for this fact in the following ingenious manner: "Let us for the purpose of illustration take three families as representing an average of the entire tribe; say that one mother gives birth to six daughters and no sons; a second mother has six sons only, whilst the third mother has three sons and three daughters. The first mother, following the tribal custom, destroys four daughters and preserves two. The second retains her six sons. The third kills two daughters and keeps one, as also her three sons. We have then from the three families nine sons and three daughters, with which to continue the breed. But whilst the males belong to families in which the tendency to produce sons is great, the females are of those of a converse inclination. Thus the bias strengthens with each generation, until, as we find, families grow to have habitually more sons than daughters."

That this result would follow from the above form of infanticide seems almost certain; that is if we assume that a sex-producing tendency is inherited. But as the above numbers are so extremely scanty, I have searched for additional evidence, but cannot decide whether what I have found is trustworthy; nevertheless the facts are perhaps worth giving. The Maories of New Zealand have long practised infanticide; and Mr. Fenton[95] states that he has met with instances of women who have destroyed four, six, and even seven children, mostly females. However, the universal testimony of those best qualified to judge is conclusive that this custom has for many years been almost extinct. Probably the year 1835 may be named as the period of its ceasing to exist." Now amongst the New Zealanders, as with the Todas, male births are considerably in excess. Mr. Fenton remarks (p. 30): "One fact is certain, although the exact period of the commencement of this singular condition of the disproportion of the sexes cannot be demonstratively fixed, it is quite clear that this course of decrease was in full operation during the years 1830 to 1844, when the non-adult population of 1844 was being produced, and has continued with great energy up to the present time." The following statements are taken from Mr. Fenton (p. 26), but as the numbers are not large, and as the census was not accurate, uniform results cannot be expected. It should be borne in mind in this and the following cases, that the normal state of every population is an excess of women, at least in all civilised countries, chiefly owing to the greater mortality of the male sex during youth, and partly to accidents of all kinds later in life. In 1858, the native population of New Zealand was estimated as consisting of 31,667 males and 24,303 females of all ages, that is in the ratio of 130.3 males to 100 females. But during this same year, and in certain limited districts, the numbers were ascertained with much care, and the males of all ages were here 7 3 and the females 61(that is in the ratio of 1 males to 100 females. It is more important for us that during the same year of 18 8, the *non-adult* males within the same district were found to be 1 8, and the *non-adult* females 14?, that is in the ratio of 1? 3 to 100. It may be added that in 1844, at which period female infanticide had only lately ceased, the *non-adult* males in one district were ?81, and the *non-adult* females only 194, that is in the ratio of 144.8 males to 100 females.

In the Sandwich Islands, the males exceed the females in number. Infanticide was formerly practised there to a frightful extent, but was by no means confined to female infants, as is shown by Mr. Ellis,[96] and as I have been informed by Bishop Staley and the Rev. Mr. Coan. Nevertheless, another apparently trustworthy writer, Mr. Jarves,[97] whose observations apply to the whole archipelago, remarks:—"Numbers of women are to be found who confess to the murder of from three to six or eight children," and he adds, "females from being considered less useful than males were more often destroyed." From what is known to occur in other parts of the world, this statement is probable; but must be received with much caution. The practice of infanticide ceased about the year 1819, when idolatry was abolished and missionaries settled in the is-

[94] *The Todas*, 1873, pp. 100, 111, 194, 196.

[95] *Aboriginal Inhabitants of New Zealand* (Government Report), 1859, p. 36.

[96] *Narrative of Tour through Hawaii*, 1826, p. 298.

[97] *History of the Sandwich Islands*, 1843, p. 93.

CHAPTER IX

SECONDARY SEXUAL CHARACTERS IN THE LOWER CLASSES OF THE ANIMAL KINGDOM

WITH animals b lo g to th l we classes, the two sex s are n t ar ly nited n th sam indi d al, and th fo e ec da y xual characte can ot be de l ped In many cas h re th are separ t b th permanently tt ched t som s ppo t, an l h ca t ea h truggl f th ther

be ty th tt act ns, to feel rival y
 H ce thes las es ub-ki gd ms, ch

q ired thro gh se l select wh ch d pends th ll, d and ho f th r sex. N th less som f w ppar t cep-

mal h ld th f m le, and wh ch ar d spensabl f th p p g t n f the peci ar d pe d t f se l lect n, and ha be acq ed through d ry select

Many f th l imals, wh th h maphrodites w th separ t se s, re m m ted w th th m t brill t tints, are haded and tr ped an l gant m n f in tance many co ls and m (Ac tin æ) som j lly fish (Med sæ, l p ta, &) som Pl nar æ, many tar fi h Ech m as cid ans & b t may co l d f m the asons lready d cated, m ly th f th t se so f th anim ls, th perman tly ffi ed co dit n f th s, and the l w m ntal po f ll th t ch col urs d t r as se l ttract and ha t bee q ed thr gh se al selec t It h ld b born m d th t in case h w uffici t d that col ur ha bee th acq ed cept wher se m ch more b lliantly co p ly col ur d than th ther and wh ther

d ff r nce n h b ts between the sexes suffi cient to eco t f th d ffe e t col u But the e de ce is r d ed as complete as it ca er be ly l en th m re m me ted d d ls, alm t l j ll m l s, ol n tar ly d play th s ttr ct bef th e th se f r w caun t bel e th t l i-pl y seless, l f t l ad t ge s, e l s lecti n w ll almo t tably f ll W may howe r xt nd th co cl on t both sexes, h n col ured al ke f th col rs a pl ly nal g us to th se of ne se al n e tai th r pec s f th e sa g up
 H w th are we to account f th e b auti

w ll b admitted by ery e who ad Mr W llace cell t ssay o th subject It ld t, f nst t fir t occu t ar y o th t th t an pa f th e Med æ, or j lly fi l f th h gl e t se ce to th m as a

appe ce ft n accompa ed by pri m t c col rs, w c n l rdly do bt th t th y th s se pe the t ce f pelag b rd and th er en m es. M G ard also co ced th t the bright t t f certain po g and ascid ans se as protect n Co p cu colou s ar l k w se b fici l to many an mals as a w rn g to th w ld b d urers th t th y di tast f l th t th y po sess som pecial me s f d fence b t th bject will b d s-ssed m con tly l aft
 W an gn tance f m t of th l w t animals nly say th t th l right t t re lt th e f m th chem cal ture or th m n t tr tur f th tis d p nd tly f any b n fit th d ed H rdly any col fi than th t of rt l blood b t th re is ason t pp th t the col f th blood tself any ad antag and th gh t add t th b ty f th n d n heek n n w ll prete d that t has be n acqui ed for

Arch des de Zoolog Expér Oct. 1872, p 563

posed to be one chief cause of the practice of female infanticide

In no case as far as we can see would an inherited tendency to produce both sexes in equal numbers or to produce one sex in excess be a direct advantage or disadvantage to certain individuals more than to others for instance an individual with a tendency to produce more males than females would not succeed better in the battle for life than an individual with an opposite tendency and therefore a tendency of this kind could not be gained through natural selection Nevertheles there are certain animals (for instance fishes and cirripedes) in which two or more males appear to be necessary for the fertilisation of the female and the males accordingly largely preponderate but it is by no means obvious how this male producing tendency could have been acquired I formerly thought that when a tendency to produce the two sexes in equal numbers was advantageous to the species it would follow from natural selection, but I now see that the whole problem is so intricate that it is safer to leave its solution for the future

pending on its mann r of growth. The amount of light seems t be influ ntial to a certain extent for altho h, as repe tedl stated b Mr Gwyn Jeffreys, th sh lls of some species living at prof und d pth are brightl col ured. t w g rally see th lowe surfaces, as w ll as th parts co red by th mantle, less highl -coloured than th uppe and x posed surfaces. In som cases, as w th shells livin amongst corals brightl ti ted se weeds, the bri ht colours ma serv as protectio B t tl I many of th n dibranch Mol

ures

All

from inf rmati n kindl gi n m b M Hancock, t seems xtremely d ubtful wh th these colours usually serv as protect n. W th som pecies this ma be th case as with ne kind whi h lives th green lea es algæ and is tself bright green. B t many brightl -colo red whit th rwise co spicu us pecies, d t seek concealm t hilst again som equall consp cu us species, a w ll as th dull-col red kind h und

their pare ts gre t be ty B t with such lowl -organised cre tures this xtrem ly improbabl m t t all obvi us h w th off pring from th more be tiful pairs of herm phrodit would ha an ad antag th off pring of th less be tif l, so as to increase in umbe unless indeed vi our and bea t g nerall coincided W h not h re the case of n mbe f males becoming mature bef re the f males, with th more bea tiful males selected b th m re vigorous females. If indeed, brilliant colours w re be eficial to h rmaphrod t animal in relati n to the general hab ts of life, the more brightl tinted indi d ls w uld s cceed best and w uld ncrease in number but this w ld be a case of nat ral and not of sexual select n.

Sub-ki gdom of the VERMES. Class ANNELIDA (or Sea w rms) —In this class, al though the sexes, wh n separate sometimes diff from ach oth in characters f ch importance that th y h been placed und distinct g era o n famil es, yet th diff r ence do n t seem of th kind whi h can be safely attributed to sexual selecti n. These animals are often be utifully coloured b t as th se e d n t diff in this respect, we are but littl co cerned with th m. E n th nem rtians, though so lowly organised, in be ty and ari ty of colouring with any ther gro p in th in rt brat seri " yet D McIntosh cann t discov that these colours are of an service The sed ntary ann lids become dulle -coloured, according to M Quatrefages, after th period f reproduction and this I presume may be ttributed to th ir less vi orous conditi n at that tim All these w rm lik animals pparently tand too low in the scal f r the indi duals of either sex t rt any cho ce in selecting a partne o f the indi iduals of the same sex to struggle togeth in ri alry

S b-k gdom of the ARTHROPODA Class CRU T CEA.—In this gre t lass we first meet with undo bted secondary sexual charact rs, oft n d loped in a remarkable mann r. U f rtunat ly th hab ts of crustaceans are ry imperfectl kn wn, and w cannot xplain tl uses of man tru t res pec liar t on sex. W th th l w parasitic speci the males are of small size and th alo are furnished with perfect swimming legs, ant nnæ and senseorgans th f males being destit t of these organs, with th ir bodies ft n consisting of a mere distorted mass. B t these xtraordinary diff re ces between th tw sexes are no d ubt related to th ir wid ly diff rent hab ts of life, and consequ ntl d n t co cern us. In ari us crustaceans, belo ging t distin t famili s, the ant n ant nnæ are furnished with peculiar thread lik bodies, which are bel ed t act as sm lling-o gans, and these are much m re num rous in the males than in the f mal s. As

I have give (*Geological Observations on Volcanic Islands* 1844 p. 53) curious instance of the influence of ligh the colours of fro desce t incrustatio depos ed b the surf the coast rocks of Ascensio nd f rmed by the solutio of triturated sea-shells.

D M rse has lat ly discussed th subject in his paper he Adap Coloration of Mollusca, *Proc Boston Soc of Nat. Hist.*, ol. xi April, 1871

See his beautiful m graph *British A nelids*, part i., 1873, p. 3.

See M. Perrier L Origine d l Homme d pres Darwin, *Revue Scientifique* Feb 1873, p. 866.

this purpose So again with many animals especially the lower ones the bile is richly coloured thus as I am informed by Mr Hancock the extreme beauty of the Eolidæ (naked sea slugs) is chiefly due to the biliary glands being seen through the translucent integuments—this beauty being probably of no service to these animals The tints of the decaying leaves in an American forest are described by every one as gorgeous yet no one supposes that these tints are of the least advantage to the trees Bearing in mind how many substances closely analogous to natural organic compounds have been recently formed by chemists and which exhibit the most splendid colours it would have been a strange fact if substances similarly coloured had not often originated independently of any useful end thus gained in the complex laboratory of living organisms

The sub-kingdom of the MOLLUSCA Throughout this great division of the animal kingdom as far as I can discover secondary sexual characters such as we are here considering never occur Nor could they be expected in the three lowest classes namely in the ascidians Polyzoa and brachiopods (constituting the Molluscoida of some authors) for most of these animals are permanently affixed to a support or have their sexes united in the same individual In the Lamellibranchiata or bivalve shells hermaphroditism is not rare In the next higher classes of the Gasteropoda or univalve shells the sexes are either united or separate But in the latter case the males never possess special organs for finding securing or charming the females or for fighting with other males As I am informed by Mr Gwyn Jeffreys the sole external difference between the sexes consists in the shell sometimes differing a little in form for instance the shell of the male periwinkle (*Littorina littorea*) is narrower and has a more elongated spire than that of the female But differences of this nature it may be presumed are directly connected with the act of reproduction or with the development of the ova

The Gasteropoda though capable of locomotion and furnished with imperfect eyes do not appear to be endowed with sufficient mental powers for the members of the same sex to struggle together in rivalry and thus to acquire secondary sexual characters Nevertheless with the pulmoniferous gasteropods, or land snails the pairing is preceded by courtship for these animals, though hermaphrodites are compelled by their structure to pair together Agassiz remarks, *Quiconque a eu l'occasion d'observer les amours des limaçons ne saurait mettre en doute la séduction déployée dans les mouvements et les allures qui préparent et accomplissent le double embrassement de ces hermaphrodites* [1] These animals appear also susceptible of some degree of permanent attachment an accurate observer Mr Lonsdale informs me that he placed a pair of land snails (*I*

weakly

After a s

dividual disappeared and was traced by its track of slime over a wall into an adjoining well stocked garden Mr Lonsdale concluded that it had deserted its sickly mate but after an absence of twenty four hours it returned, and apparently communicated the result of its successful exploration for both then started along the same track and disappeared over the wall

F n in the highe t class of the Mollusca,

1 11 ale el ped

from an enemy [2] Certain Cephalopoda however are characterised by one extraordinary sexual character namely that the male element collects within one of the arms or tentacles which is then cast off and clinging by its sucking discs to the female lives for a time an independent life So completely does the cast off arm resemble a separate animal that it was described by Cuvier as a parasitic worm under the name of Hectocotyle But this marvellous structure may be classed as a primary rather than as a secondary sexual character

Although with the Mollusca sexual selection does not seem to have come into play yet many univalve and bivalve shells, such as volute

colour

pear n

ti n they are probably the direct result, as in the lowest classes of the nature of the tissues the patterns and the sculpture of the shell de-

[1] De l

[2] See

n my

equalit in th f male on the opposite sides of th bod In G lasimus, according to a statement quoted by Milne Edwards, the male and the female liv in th sam burrow and this shew that they pai the mal loses th mouth of the burrow with one of its ch lie which is enorm usl de eloped so that h re it

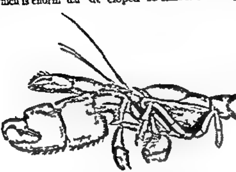


FIG. 5 Anterior part of body of Callianassa (from Milne Edwards), showing the unequal nd diff re tly-constructed right nd left hand chelæ of the male
N B The artist by mistak has re ersed th drawing and made the left hand chela th largest.

FIG. 6

FIG 7

FIG. 6 Second leg of male *Orchestia tucuratinga* (from Fritz Müller).

FIG. 7 Ditto of female.

indirectl serves as m ans of d fence Th ir main se howe is probabl to seize and t secure the f male and thus in som instances, as th Gammarus, is kn wn to be th case Th male of th h rmit or soldie crab (Pagurus) for weeks togethe carries bo t th sh ll nhab ted b th f mal [13] Th sexes, how of th common shore-crab (Carcinus manas) as M Bat informs m unit directly after th f male has m ulted her hard sh ll, whe sh *is so soft that she w uld* be injured if seized b th trong p ncers of the mal b t as sh is caught and carried about by the male before moulting, she could then be seized with impun ty

Fritz Müller states that certain species f M lita are distinguished from all oth amphi pods by the f males ha ing the coxal lam llæ f th pe ultimate pair of feet produced into hook like processes, of which the males lay hold with the hands of th first pair The d lopm nt f these hook like processes has probably followed from those f males which were th most securely held during the act of reproduc ti n, havin l ft th largest numbe of off pring An ther Brazilian amphipod (*Orchestia darwi i*, fig 8) presents a case of dim rphism, like th t of Tanais f r th re are tw mal f rms, which differ in th tru t re of their chelæ [14] A eithe h l w ll cert ly suffice to hold the f

mann r and som in anothe both forms ha ng d ri ed certain special, b t nearly equal ad antages, from their diff re tly sh ped rgans.

It is n t known that male crustaceans fight to the f the possession of the f males, but t is probably the case for with most animals wh n th mal is larg r than th f male, h seems to we his gre te size to his ancestors ha ing fo ght with other males during man gen rati ns. In most of the ord rs, especially in th highest or th Brach ura, the mal is larg than th f mal th parasiti gen ra, h w in which th sexes f llow diff re t hab ts of life, and most of th Entomostraca must be excepted. Th ch læ of many crustaceans are we pons w ll ad pted f fighting. Thus when a devil crab (*Port us p ber*) was seen by a son of M Bat fighting with *Carci us manas* th latt was soo thrown n its back, and had ry limb torn from ts body Wh n se ral males of a Brazilian G lasimus, speci fur nished with imm nse pincers, w re placed tog th n a glass essel b Fritz Müll r th y mutilated and killed an th Mr B t p t a larg male *Carci us manas* to a pan f w t nhab ted by f mal which was paired with a small mal b t th latt was

[13] *Hist. Nat. de Crust.*, tom. ii., 1837 p. 50.
Mr C pence Ba *British Association, Fourth Report on the F una of S. Devon.*

[14] Fritz Muller *Facts and Arguments for Darwin*, 1869 pp. 25-28.

the males without any unusual development of their olfactory organs would almost certainly be able sooner or later to find the females the increased number of the smelling threads has probably been acquired through sexual selection by the better provided males having been the more successful in finding partners and in producing offspring Fritz Müller has described a remarkable dimorphic species of Tanais in which the male is represented by two distinct forms which never graduate into each other In the one form the male is furnished with more numerous smelling threads and in the other form with more powerful and more elongated chelæ or pincers which serve to hold the female Fritz Müller suggests that these ... ween the ... nay have ... ng varied ... nuer of the smelling threads whilst other individuals varied in the shape and size of their chelæ ...

... t the greatest number of progeny to inherit their respective advantages[2]

In some of the lower crustaceans the right anterior antenna of the ...

... as I hear from Sir J Lubbock to hold the female and for this same purpose one of the two posterior legs (b) on the same side of the body is converted into a forceps In another family the inferior or posterior antennæ are curiously zigzagged in the males alone

In the higher crustaceans the anterior legs are developed into chelæ or pincers and these are generally larger in the male than in the female —so much so that the market value of the male edible crab (*Cancer pagurus*) according to Mr C Spence Bate is five times as great as that of the female. In many species the chelæ are of unequal size on the opposite side of the body the right hand one being, as I am informed by Mr Bate generally though not invariably the largest. This inequality is also often much greater in the male than in the female The two chelæ of the male often differ

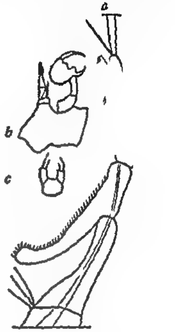


FIG 4 *Lab dor d ... (from Lubbock). a P rt f r ght nt r r nt n a f m le, f rming a perh ... l o g n b l ... p ir f thor c leg of m l ... D ... of female*

in structure (figs ... and 7) the smaller one resembling that of the female What advantage is gained by the ... when they are of equal size both are often much lar...

... they cannot possibly be used for carrying food to the mouth In the males of certain fresh water prawns (Palæmon) the right leg is actually longer than the whole body[4] The great size of the one leg with its chelæ may aid the male in fighting with his rivals but this will not account for their ...

Facts and Arguments for Darwin English translat. 1869 p 20 ... 870 p 455) ... 1853 pls ... (1853) pl ... See also Lubbock in *Transactions Entomological Society* ... new series, 1856-1858 p 8 With respect to the zigzagged antennæ mentioned below see Fritz Müller *Facts and Arguments for Darwin*, 1869 p 40 footn ...

See a paper by Mr C Spence Bate ... the figures ... *Zoological Society* 1868 p 363 ... literature of the genus, *ibid* p 585 I am greatly indebted to Mr Spence Bate for nearly all the above statements with respect to the chelæ of the higher crustaceans.

In this case we may suspect the agency of sexual selection. From M. Bert observations on a ... vessel illumi...

... are absent in the females, and in both sexes of one species.[14] It would, however, be extremely rash to conclude that these curious organs serve to attract the females. I am informed by Fritz Müller that in the female of a Brazilian species of Glaucus, the whole body is of a nearly uniform greenish-brown. In the male the posterior part of the cephalo-thorax is pure white, with the anterior part of a rich green, shading into dark brown; and it is remarkable that these colours are liable to change in the course of a few minutes,—the white becoming dusty grey or ... black, the green losing much of its brilliancy. It deserves especial notice that the males do not acquire their bright colours until they become mature. They appear to be much more numerous than the females; they differ also in the larger size of their chelae. In some species of the genus, probably in all, the sexes pair and inhabit the same burrow. They are also, as we have seen, highly intelligent animals. From these various considerations it seems probable that the male in this species has become gaily ornamented in order to attract ... the female.

It has just been stated that the male Glaucus does not acquire his conspicuous colours until mature and nearly ready to breed. This seems a general rule in the whole class in respect to the many remarkable structural differences between the sexes. We shall hereafter find the same law prevailing throughout the great sub-kingdom of the Vertebrata; and in all cases it is eminently distinctive of characters which have been acquired through sexual selection. Fritz Müller gives some striking instances of this law; thus the male sand-hopper (Orchestia) does not, until nearly full grown, acquire his large claspers, which are very differently constructed from those of the female; whilst ... young, his claspers resemble those of the female.

Class, ARACHNIDA (Spiders).—The sexes do not generally differ much in colour, but the males are often darker than the females, as may be seen in Mr. Blackwall's magnificent work. In some species, however, the difference is conspicuous: thus the female of *Sparassus smaragdulus* is dullish green, whilst the adult male has the abdomen of a fine yellow, with three longitudinal stripes of rich red. In certain species of Thomisus the sexes closely resemble each other; in others they differ much; and analogous cases occur in many other genera. It is often difficult to say which of the two sexes departs most from the ordinary coloration of the genus to which the species belong; but Mr. Blackwall thinks that, as a general rule, it is the male; and Canestrini remarks that in certain genera the males can be specifically distinguished with ease, but the females with great difficulty. I am informed by M...

...

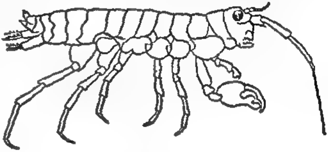
...ccessive moults, before arriving at maturity. In other cases the male alone appears to change colour. Thus the male of the above bright coloured Sparassus at first resembles the female, and acquires his peculiar tints only when nearly adult. Spiders are possessed of acute senses, and exhibit much intelligence; as is well known, the females often show the strongest affection for their eggs, which they carry about enveloped in a silken web. The males search eagerly for the females, and have been seen by Canestrini and others to fight for possession of them. This same author says that the union of the two sexes has been observed in about twenty species; and he asserts positively that the female rejects some of the males who court her, threatens them with open mandibles, and at last after long hesitation accepts the chosen one. From these several considerations, we may admit with some confidence that the well-marked differences in colour between the sexes of certain species are the results of sexual selection; though we have not here the best kind of evidence,—the display by the male of his ornaments. From the extreme variability of colour in the male of some species, for instance of *Theridion lineatum*, it would appear that

I am indebted to Mr. Bates for ... statement.

[14] ... *Die freilebenden Copepoden*, 1863, s. 5a. *Facts and Arguments*, &c., p. 9.

... Arachnids, in the *Atti della Soc. Veneto-Trentina di Sc. Nat. Padova*, vol. ... fasc. 3, 1873.

soon dispossessed Mr Bate adds if they fought the victory was a bloodless one for I saw no wounds This same naturalist separated a male sand skipper (so common on our sea shores) *Gammarus marinus* from its female both of whom were imprisoned in the same vessel with many individuals of the same species The female when thus divorced soon joined the others After a time the male was put again into the same vessel and he then after swimming about for a time dashed into the crowd and without any fighting at once took away his wife This fact shews that in the Amphipoda an order low in the scale the males and females recognise each other and are mutually att ed



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tries to catch one of the shore crabs so common on tropical coasts will perceive how wary and alert they are. There is a large crab (*Birgus latro*) found on coral islands which makes a thick bed of the picked fibres of the cocoa nut at the bottom of a deep burrow It feeds on the fallen fruit of this tree by tearing off the husk fibre by fibre and it always begins at that end where the three eye like depressions are situated It then breaks through one of these eyes by hammering with its heavy front pincers and turning round extracts the albuminous core with its narrow posterior

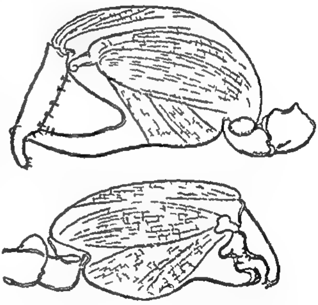


Fig 8 O h t a l n (fr k t M ll) h g the differently-c n tructed ch l e f th m l f rms.

mal as by an old one The following case however can hardly be n considered a trustworthy naturalist Mr Gardner [1] whilst watching a shore crab (Gelasimus) making its burrow threw some shells towards the hole One rolled in and three other shells remained within a few inches of the mouth In about five minutes the crab brought out the shell which had fallen in and carried it away to a distance of a foot it then saw the three other shells lying near and evidently thinking that they might likewise roll in carried them to the spot where it had laid the first It would I think be difficult to distinguish this act from one performed by man by the aid of reason

Mr Bate does not know of any well marked case of difference of colour in the two sexes of our British crustaceans in which respect the sexes of the higher animals so often differ In some cases however the males and females differ slightly in tint, but Mr Bate thinks not more than may be accounted for by their different habits of life such as by the male wandering more about and being thus more exposed to the light Dr Power tried to distinguish by colour the sexes of the several species which inhabit Mauritius but failed except with one species of Squilla probably S stylifera the male of which is described as being of a beautiful bluish green with some of the appendages cherry red whilst the female is clouded with brown and grey with the red about her much less vivid than in the male

[1] T els th Int rior f B il 1846 p 111 I have given in my J l f R rch p 463 an account of the habits of the Birgus.

[2] Mr Ch. Fraser n P oc Zoolog Soc 1869 p 3

CHAPTER X

SECONDARY SEXUAL CHARACTERS OF INSECTS

In the immense class of insects the sexes sometimes differ in their locomotive-organs, and often in their sense-organs, as in the pectinated and beautifully plumose antennae of the males of many species. In Chloëon, one of the Ephemerae, the male has great pillared eyes, of which the female is entirely destitute. The ocelli are absent in the females of certain insects, as in the Mutillidae; and here the females are likewise wingless. But we are chiefly concerned with structures by which one male is enabled to conquer another, either in battle or courtship, through his strength, pugnacity, ornaments, or music. The innumerable contrivances, therefore, by which the male is able to seize the female, may be briefly passed over. Besides the complex structures at the apex of [illegible]

for the seemingly insignificant object of enabling the male to grasp the female firmly. The mandibles or jaws are sometimes used for this purpose; thus the male *Corydalis cornutus* (a neuropterous insect in some degree allied to the dragon flies, &c.) has immense curved jaws, many times longer than those of the female; and they are smooth instead of being toothed, so that he is thus enabled to seize her without injury. One of the stag-beetles of North America (*Lucanus elaphus*) uses his jaws, which are much larger than those of the female, for the same purpose, but probably likewise for fighting. In one of the sand-wasps (Ammophila) the jaws in the two sexes are closely alike, but are used for widely different purposes; the males, as Professor Westwood observes, "are exceedingly ardent, seizing their partners round the neck with their sickle-shaped jaws"; whilst the females use these organs for burrowing in sand-banks and making their nests.

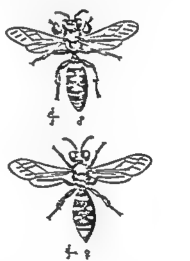


Fig. 9. Crabro cribrarius. Upper figure male; lower figure female.

The tarsi of the front-legs are dilated in many male beetles, or are furnished with broad cushions of hairs; and in many genera of water-beetles they are armed with a round flat sucker, so that the male may adhere to the slippery body of the female. It is a much more unusual circumstance that the females of some water-beetles (Dytiscus) have their elytra deeply grooved, and in Acilius sulcatus thickly

1 Sir J. Lubbock, *Transact. Linnean Soc.*, vol. xxv, 1866, p. 484. With respect to the Mutillidae see Westwood, *Modern Class. of Insects*, vol. ii, p. 213.

2 These organs in the male often differ in closely-allied species, and afford excellent specific characters. But their importance, from a functional point of view, as Mr R. MacLachlan has remarked to me, has probably been overrated. It has been suggested, that slight differences in these organs would suffice to prevent the intercrossing of well-marked varieties or incipient species, and would thus aid in their development. That this can hardly be the case, we may infer from the many recorded cases (see, for instance, Bronn, *Geschichte der Natur*, B. ii, 1843, s. 164; and Westwood, *Transact. Ent. Soc.*, vol. iii, 1842, p. 195) of distinct species having been observed in union. Mr MacLachlan informs me (*Stett. Ent. Zeitung*, 1867, s. 155) that when several species of Phryganidae, which present strongly-pronounced differences of this kind, were confined together by Dr Aug. Meyer, they coupled, and one pair produced fertile ova.

3 *The Practical Entomologist*, Philadelphia, vol. ii, May 1867, p. 88.

4 Mr Walsh, ibid., p. 107.

5 *Modern Classification of Insects*, vol. ii, 1840, pp. 205, 206. Mr Walsh, who called my attention to the double use of the jaws, says that he has repeatedly observed this fact.

these sexual characters of the males have not as yet become well fixed Canestrini draws the same conclusion from the fact that the males of certain species present two forms differing from each other in the size and length of their jaws and thus reminds us of the above cases of dimorphic crustaceans

The male is generally much smaller than the female sometimes to an extraordinary degree [0] and he is forced to be extremely cautious in making his advances as the female often carries her coyness to a dangerous pitch De Geer saw a male that in the midst of his preparatory caresses was seized by the object of his attentions enveloped by her in a web and then devoured a sight which as he adds filled him with horror and indignation [1] The Rev O I Cambridge[22] accounts in the following man

tive male escapes from the ferocity of the female by gliding about and playing hide and seek over her body and along her gigantic limbs in such a pursuit it is evident that the chances of escape would be in favour of the ... hilst the larger ones would

crative functions —in fact probably to the size we now see them ... so small as to be a sort of parasite upon the female and either beneath her notice or too agile and too small for her to catch without great difficulty

Westring has made the interesting discovery that the males of several species of Theridion[23] have the power of making a stridulating sound, whilst the females are mute The apparatus consists of a serrated ridge at the base of the abdomen against which the hard hinder part of the thorax is rubbed and of this structure

mopter... to be described in the next chapter we may feel almost sure that the stridulation serves as Westring also believes, to call or to excite the female and this is the first case known to me in the ascending scale of the animal kingdom of sounds emitted for this purpose[24]

Class MYRIAPODA —In neither of the two orders in this class the millipedes and centipedes can I find any well marked instances of such sexual differences as more particularly concern us In *Glomeris limbata* however and

In some species of Iulus the tarsi of the male are furnished with membraneous suckers for the same purpose As we shall see ... hen we treat

extremity ...

[23] D ... collected several

Kirby ... and Spence ... Introduction to Entomology ... 1818 p 280

[22] Proceedings Zoolog Society 1871 p 621

[24] Westring ... 1847 ... p 17 19 68

tat all the Lampyridæ wh ch he has tried are h ghl distasteful t insecti orous mammals and birds. H nce t s in accordance w th M Bates view hereaft to be plained that ma insects mimic the Lampyridæ losel in order to be mistak n for th m, and thus to escape estruction. He furth bel es that the luminous species profit b being t nce recognised as unpalatable. It is probable that the same planation m be ext nded to the aters, both se es of which are highl lum nous. It is not known wh th wan of the female glow worm h ve not been d elo ped b t in h prese t stat sa closel resembles larva, and as larvæ are so largel preyed n

smaller than the f males and this diff rence can often be d ected n in th larval tate so considerable is th diff rence between the male and f male cocoon of the silk moth (*Bombyx mori*) that in France th are separated b particular mo of w ghing. In the lower classes of th animal kingdom, the great s of the females seems generally to depend on their h pan an enormous number of a and this ma t certain tent hold good th insects. b t D Wallace has suggested much more probable planation. H finds, after carefull tt nding t the d lopme t of th cat rpillars of *Bombyx cynthia* and *yamamai* and especially t th t of some dwarfed cat rpillars reared from second brood on unnat ral food th t in proportion as the indi idual moth is finer so is the time required for ts metamorphosis to ge and for this reason th f male which is the large and hea ier insect, from ha ing t carry he nu merous eggs will be preceded b the male hich is smalle and has less to mat re N w as most insects are short-li ed, and as th are posed t man dan ers, t would manifestl be ad antageous t the female t be impregnated as soon as possible This nd would be gained b the males being first mat red large umbers read for th ad ent of th f males and this again ld nat ral follow as M A. R. Wallace has remarked, th ough natural selection for the smalle males would be first matured and thu would procreate a large number of off pri which would inherit the reduced s f th r male parents, whil t the large mal fr m being matured lat r would h e few off pring.

Th re are h w er e ceptions to th rule rel be smaller than the f males

f males and n these cases, as with the stag beetle (Lucanus) the males are larger than the f males. There are how er other beetles which are n t known to fight to eth of which th males xceed th f males in size and the m aning of this fact is not known but in some of these cases, as w th the huge Dynastes and M asoma, we can t least see that th re would be no necessit for the males to be smalle than th f males, in ord to be ma t red bef re th m f these beetles are n t

and as M MacLa hlan beli es, th d not nerall pai w th th f males until a week or fortnight has lapsed, and until th ha e assumed their prope masculine colours. B t the most curious case sh wing on what comple and asil o looked rel tions, so trifling haract as diff rence in siz between th se es ma d pend is that of the acul t Hym n ptera f M F Smith informs m that through ut nearly the whole of this large gro p, th males accordance w th the g neral rule re smalle than the f males, and m rge abo t a week bef re th m but amongst the bees, the males of . . . and . . . and amongst th fossores, th males of th *Methoca* . . . are larger than th females. The explanation of this anomaly . . . that a marriage flig t is absol t ly ecessary w th these spec es, and th male requires gre t trength and siz in ord to carry th f male throu th air Increased size has h re been acquired in pposition to th usual relati n between siz and th period [illegible] d elopment for th males, though larger merge before th smalle f males.

W will now revi w th se eral Ord rs, selectin such facts as more particularl con

Robinet, Ver . . . Soie, 1848, p. 207.

Transact. Ent. Soc. 3rd series, ol . . . p. 486.

Journal of Proc. Ent. Soc. . . . 1867, p. lxxi.

F r th . . . nd other st t me ts on the size of the se es, see Kirb nd Spe ce Int d . . . d . . ., p. 300 on the duratio of lif in insects, see p. 344.

set with hairs, as an aid to the male. The females of some other water-beetles (Hydroporus) have their elytra punctured for the same purpose.[6] In the male of *Crabro cribrarius* (fig. 9) it is the tibia which is dilated into a broad horny plate, with minute membraneous dots, giving to it a singular appearance like that of a riddle.[7] In the male of Penthe (a genus of beetles) a few of the middle joints of the antennæ are dilated and furnished on the inferior surface with cushions of hair, exactly like those on the tarsi of the Carabidæ, "and obviously for the same end." In male dragon-flies, "the appendages at the tip of the tail are modified in an almost infinite variety of curious patterns to enable them to embrace the neck of the female." Lastly, in the males of many insects, the legs are furnished with peculiar spines, knobs or spurs; or the whole leg is bowed or thickened, but this is by no means invariably a sexual character; or one pair, or all three pairs are elongated, sometimes to an extravagant length.[8]

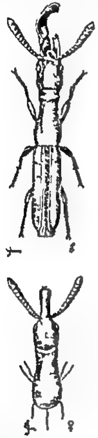


Fig. 10. *Taphroderes distortus* (much enlarged). Upper figure, male; lower figure, female.

The sexes of many species in all the orders present differences, of which the meaning is not understood. One curious case is that of a beetle (fig. 10), the male of which has left mandible much enlarged; so that the mouth is greatly distorted. In another carabidous beetle, Eurygnathus,[9] we have the case, unique as far as known to Mr. Wollaston, of the head of the female being much broader and larger, though in a variable degree, than that of the male. Any number of such cases could be given. They abound in the Lepidoptera: one of the most extraordinary is that certain male butterflies have their fore-legs more or less atrophied, with the tibiæ and tarsi reduced to mere rudimentary knobs. The wings, also, in the two sexes often differ in neuration,[10] and sometimes considerably in outline, as in the *Aricoris epitus*, which was shewn to me in the British Museum by Mr. A. Butler. The males of certain South American butterflies have tufts of hair on the margins of the wings, and horny excrescences on the discs of the posterior pair.[11] In several British butterflies, as shewn by Mr. Wonfor, the males alone are in parts clothed with peculiar scales.

The use of the bright light of the female glow-worm has been subject to much discussion. The male is feebly luminous, as are the larva and even the egg. It has been supposed by some authors that the light serves to frighten away enemies, and by others to guide the male to the female. At last, Mr. Belt[12] appears to have solved the difficulty: he finds

[6] See Dr. H. Schaum, as quoted in the 'Zoologist,' vols. 1847-48, p. 1896. Also Kirby and Spence, 'Introduction to Entomology,' vol. iii. 1826, p. 30.

[7] Westwood, 'Modern Class.' vol. ii. p. 193. The following statement about Penthe, and others in inverted commas, are taken from Mr. Walsh, 'Practical Entomologist,' Philadelphia, vol. iii. p. 88.

[8] Kirby and Spence, 'Introduct.' &c., vol. iii. pp. 332-336.

[9] 'Insecta Maderensia,' 1854, p. 20.

[10] E. Doubleday, 'Annals and Mag. of Nat. Hist.' vol. i. 1848, p. 379. I may add that the wings in certain Hymenoptera (see Shuckard, 'Fossorial Hymenop.' 1837, pp. 39-43) differ in neuration according to sex.

[11] H. W. Bates, in 'Journal of Proc. Linn. Soc.' vol.

that this is se al charact r e ceptu g th t th no social insects the seem to b n sef r sound prod ci g gans unless it be as se al call.

fifty l r se of *C pru osa* and I several tim s noti ed the femal s to l gl t near male wh le he was tteringl is langu g note Frit Mül l t stome f m S Brazil that h l as ft n l l l l

The f males re m te as the Grecian poet Xenarch says Happy the cicadas l e unce th y all ha e cel ss w s Th n se thus made co ld b pl nly l ard board the *Beagle* h n anch ed t q rt f a mile from th h e f B azil and Captain Hancock say it ca be h ard t th distance f mile The Gre ks f rm ly k pt and the Cl ese n w keep tl se insect g s f r tl e

l o h find th m by the r so nds, but that I ke f mal b rds they are cited r all ed by the mal tl th m t attract e vo ce

I l ve n t h rd of a g well marked ases f rnament l d ff ren es b tween the se of tl e H m ptera Mr D uglas f m me tl t tl e e three British pecies, i wl ich tl e mal bl ck or m ked w th black b ds wl lst th f mal re p le-col ed r bsc re

Ord O TH PTERA (C kets and Grass- l pers) —The males in the three saltat rial

b an set to act by spec l m scl In th l g sect, h lst t d lat g th m m b an can be sec to b t d th d ad nsect tl proper sound h rd f th m scl h l ttl d d nd hard ed pulled with th po t f p In th f mal th wh l complex mus cal pp t p sent b t is m h less d loped than th mal d sc l f g od ng sound

W th pect t th bject f th mus D Hartman peaking f tl *Cic d ptem decim* f th U ted States, says,[58] Th d ms are (J C(h d tl 1851) heard ll directio Th I b l t b th mart al mm ns f m th mal Stand g n th k l t t pro t also t as h gl as my l ad l re h nd ed re und m I bse ed tl f mal s com ng *round th d mm g* mal H lds. Tl seaso (A g 1868) a d rf pear tree my g rden j rod ed bo t

eq le t Engl h m and the A rid dæ o gras h pp Th trid lat n prod ced by some f the Locu tidæ is so l d that it can be h ard d ri g tl gl t t the distance f m l [61] and that mad by ce tain pec es is n t unm l n to the l man ar so that th Ind ans th Amazo keep tl m in wicke cages All bsers rs gree tl t the sou d ri itl t call tle tl mute f males. W th pect to th mig atory locu ts f R s- ia, K rt has gi n[62] n u t ting case f select by th f m l f mal The m l f tl pec (*I och ptylus m g at*) whil t upled th th f mal t d l t from ang j l y if pp ached by th r males Tl t use-cri k t he urprised t n ght use ts ce t warn t f ll w [63] In N rth Am ri th katyd d (*Platyphyll m c ca m f th Locustidæ*) is described[64] as mo t g n the uppe b h f tree and n th ning beginn g hi y babble wh l ri al n t iss from tl n glibo ring tr and tl gr so d th th ll f *Kat j-did*

[58] These p rticulars are tak from W t ood *Moder (l f son f I sects* l. 1840 p 422. See lso tl Fulg dæ, Kirby d pe ce *Int oduct* l. p 401

Zeitschrift f senschaft Zoolog B xvii. 1867 152 158

T nsact ns of the New Zealand Institute, l. 18 3 p 286

I m debted t M W Lh for hs g se t m this ract from *A J rnal f the Do g Cic d pt dec m*, t y D Hartm n.

L. Guild g *T nsact f tl L nne Society* l 155

1825 p 262.

H rr s, *Insect f N Engl nd*, 1842, p 128

cern us The Lepidoptera (butterflies and moths) will be retained for a separate chapter

Order THYSANURA —The members of this lowly organised order are wingless dull coloured minute insects with ugly almost misshapen heads and bodies Their sexes do not differ but they are interesting as shewing us that the males pay sedulous court to the females even low down in the animal scale Sir J Lubbock[17] says It is very amusing to see these little creatures (*Smynthurus luteus*) coquetting together The male which is much smaller than the female runs round her and they butt one another standing face to face and moving backward and forward like two playful lambs Then the female pretends to run away and the male runs after her with a queer appearance of anger gets in front and stands facing her again then she turns coyly round but he quicker and more active scuttles round too and seems to whip her with his antennæ then for a bit they stand face to face play with their antennæ, and seem to be all in all to one another

Order DIPTERA (Flies) —The sexes differ little in colour The greatest difference known to Mr F Walker is in the genus Bibio in which the males are blackish or quite black and the females obscure brownish-orange The genus Elaphomyia discovered by Mr Wallace[18] in New Guinea, is highly remarkable as the males are furnished with horns of which the females are quite destitute The horns spring from beneath the eyes and curiously resemble those of a stag being either branched or pal m t d T [illegible] s equal the [illegible] be thought [illegible] one species [illegible] edged with black, with a pale central stripe and as these insects have altogether a very elegant appearance it is perhaps more probable that they serve as ornaments That the males of some Diptera fight together is certain Prof West Wood[19] has several times seen this with the Tipulæ. The males of other Diptera apparently try to win the females by their music H Muller[20] watched for some time two males of an Eristalis courting a female they hovered above her and flew from side to side making a high humming noise at the same time Gnats and mosquitoes (Culicidæ) also seem to attract each other by humming and Prof Mayer has recently ascertained that the hairs on the antennæ of the male vibrate in unison with the notes of a tuning fork within the range of the sounds emitted by the female The longer hairs vibrate sympathetically with the graver notes and the shorter hairs with the higher ones. Landois also asserts that he has repeatedly drawn down a whole s [illegible]

[illegible] in most other insects in accordance with their highly-developed nervous system [21]

Order HEMIPTERA (Field Bugs) —Mr J W Douglas who has particularly attended to the British species has kindly given me an account of their sexual differences The males of some species are furnished with wings, whilst the females are wingless the sexes differ in the form of their bodies elytra antennæ and tarsi but as the signification of these differences is unknown they may be here passed over The females are generally larger and more robust than the males With British and as far as Mr Douglas knows with exotic species, the sexes do not commonly differ much in colour but in about six British species the male is considerably darker than the female and in about four other species the female is darker than the male Both sexes of some species are beautifully coloured and as these insects emit an extremely nauseous odour their conspicuous colours may serve as a signal that they are unpalatable to insectivorous animals In some few cases their colours a [illegible]

[illegible] is said to be effected by the movement of the neck within the prothoracic cavity According to Westring *Reduvius personatus* also stridulates But I have no reason to suppose

[17] Transact Linnean Soc [illegible] 1868 p 296

[18] The Malay Archipel [illegible] 1869 p 313

[19] Modern Classif of Insects [illegible] 1840 p 526

[20] Anwend [illegible] &c [illegible] Jahrg [illegible] p 80 Mayer in *American Nat* [illegible] 1874 p 236

[21] See Mr B T Low [illegible] [illegible] to disappear

[22] Westwood Modern Classification of Insects [illegible] p 473

that this is sex l haracte cepting that th social insects the e seems t be n use f sound prod ing o gans unl ss t be as sexual call.

Ord II MOPTERA —E ry e who has nd red n a trop al f t m st ha been astonished t th di mad by the male C'cadæ. The f mal s are m te as the Grec poet Xenarchus says, H ppy the ci adas l e since th y all ha e cel ss wi Th n ise thus mad co ld be plainly h ard n bo rd th B gl wh an h ed t a q art f

l ht so g t rs Th sound ac

that is prou ed b an set to act by a pecial m scl In th l g nsect, whil t trad l t g, this m m bra can b see t brat and th d ad insect tl prope so nd h rd l th m scl h l ttl dried and hard ed p lled w th the po t l I th f mal th wh l compl mus cal pp tus s prese t h t is m h less d l ped than th mal and

direct ns This I bel t b th m rt al mm ns from th m l Stand g in th ck l t t pro t abo t as h gh as my l ad l re l nd ed w re ro d m I bse ed tl f mal com g ro d th d mming les H dds, Th seaso (A g 1868) d f pear tree my gard prod ed bo t

fifty larvæ f C prui osa and I se eral times n t ced the f m l s t alight n ar a male while h was uttering his clangi g notes. Fritz Mül le writ st m f om S Brazil that l e has oft n h t ned t a musical o te t b tween two or three male f a pecie with a particularly l d ce se ted t a cons d rable d st ce from each tl r as soon as one had fini l d l is song an th r imi ed t ly begun, and tl en n th As th re so much r alry betwee th males, t s probabl th t the f mal s n t nly find th m by the r sounds, b t that l ke f male birds, th y are ted o all red by the male w th th m t ttract o ce

I h e n t he rd f any w ll ma ked case f rn mental diff rences b tween th se es f the H mopt r Mr Douglas i f rms n II t th re are three Brit.l pec s, n wl cl the mal i black r marked w th black bands, wl l t th fem le are p l -col ured obsc re

Ord r ORTHOPTERA (C ick t nd Grass-l rs) —Tl mal in the th ee saltat al f

unm al n to the h man r so that th Ind ans n th Amazon keep th m in wicker c ges. All obser s gree that the so ds se e tl r t call te tl m to f males. W th re pect t th m gr tory locu ts of R s-a, K rt l as gi n[48] an int re ting case f select n by tl f m l f a m l Tl m les f thus peci (Pachytyl m gratorius) wl lst co pled with the f male t d late from anger l l y if pp oached by th mal Th h use-cri k t wh n rprised t n ght us s its ce t warn t f ll w [49] In N rth America th Katyd d (Platyphyllum arum f th Locustidæ) is desc bed[50] as m nt g n tl ppe b an h s f tree and in th e ning beginning h n y babble, while ri al n t iss f m tl n gl bouring trees, and th g reso nd th tl all f Katy-did

[a]These particulars re tak from W t ood Modern Cl ssifi f Insects l 1840 p. 422. See also the Fulgoridæ, K by d pe ce Introduct l p 401

Zeitsch ft f wissensch ft Zoolog B 1867 152 158.

T nsact ons of the New Z aland Institute, l 1873 p 256

I am debted t M Walsh for h g se t m this tract from A J nal f the Doo g C d scripti ndens by D Hartman.

[48] L G ild g T nsact f the L nne Society 1875 p 262.

[50] Harris, Insect f N w E gl nd, 1842, p. 128.

she-did the live long night Mr Bates in speaking of the European field cricket (one of the Achetidæ) says the male has been observed to place himself in the evening at the entrance of his burrow and stridulate until a female approaches when the louder notes are succeeded by a more subdued tone whilst the successful musician caresses with his antennæ the mate he has won [31] Dr Scudder was able to excite one of these insects to answer him by rubbing on a file with a quill [32] In both sexes a remarkable auditory apparatus has been discovered by von Siebold situated in the front legs [33]

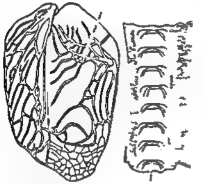


FIG 11 *Gryll s ca p t* (from Land) Right ha d f gu e u d r de of part f a wi g n h gn fied sho ing th t th (*st*) L ft h d figure upper sur f f g c th tl e pr ject ng m th n r h ch th te th (*st*) a ped

In the three families the sounds are differently produced In the males of the Achetidæ both wing covers have the same apparatus and this in the field cricket (*Gryllus campestris* fig 11) consists as described by Landois [4] of from 131 to 138 sharp transverse ridges or teeth (*st*) on the under side of one of the nervures of the wing-cover This toothed nervure is rapidly scraped across a projecting smooth hard nervure (*r*) on the upper surface of the opposite wing First one wing is rubbed over the other and then the movement is reversed Both wings are raised a little at the same time so as to increase the resonance In some species the wing-covers of the males are furnished at the base with a talc like plate [34] I here give a drawing (fig 12) of the teeth on the under side of the nervure of another species of Gryllus viz *G domesticus* With respect to the formation of these teeth Dr Gruber has shown[35] that they have been developed by the aid of selection from the minute scales and hairs with which the wings and body are covered and I came to the same conclusion with respect to those of the Coleoptera But Dr Gruber further shews that their development is in part directly due to the stimulus from the friction of one wing over the other

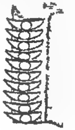


FIG 12 T eth f N rvure f *G yll s domes i cus* (f m La d is)

In the Locustidæ the opposite wing-covers differ from each other in structure (fig 13) and the action cannot as in the last family be reversed The left wing which acts as the bow lies over the right wing which serves as the fiddle One of the nervures (*a*) on the under surface of the former is finely serrated and is scraped across the prominent nervures on the upper surface of the opposite or right wing In our British *Phasgonura viridissima* it appeared to me that the serrated nervure is rubbed against the rounded hind-corner of the opposite wing the edge of which is thickened coloured brown and very sharp In the right wing but not in the left there is a little plate as transparent as talc surrounded by nervures and called the speculum In *Ephippiger vitium* a member of this same family we have a curious subordinate modification for the wing covers are greatly reduced in size but the posterior part of the pro-thorax is elevated into a kind of dome over the wing-covers and which

[31] *The Nat ralist n the Am zons* vol 1863 p 252 Mr B tes gi y t ti g d cuss n n

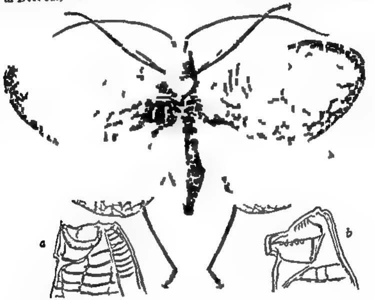
tory L xi Apr l 1868
[32] No r u *M* *el d l at C mp* French tr nslat. m 1 1850 567
Z itschrift fur wiss nsch ft. Zoolog xvi 1867 s. 117

[34] W twood *Mod Cl fi t f Insects* i. p 440
[35] Ube d r T pp t ler Loc t d n B t g D us *Z itschrift f wissensch ft Zool g* B 1872, p. 100

has prob bly the ffect of ı creasing the sound.

W thus see th t th mus cal pp ratu s m re diff t ted pecı l ed n th Locustidæ (which ın I d I bel th m t po rful perf rm rs n the Orde) than ın the Ach tidæ, ın whı h both w -co e s h th same tru t re and th same fun t [28] Lan d ıs, how r d tected n f th Locustidæ nam ly ın Dect cus, sh rt and narrow tary teetl ar comm nly f und n tl e inf r s rface f tl gl t wing By wh t tep tl t ı n tl e Ach t dæ orıgı

anu t
a gr tıng sound as ıs n w tl ase with tı w g-co s of th f males [29] A gratı g sou l thus occası nally and ıcıde tally made by



F a.15 *Chloroe l T na (from B tes)* b Lobe f ppos t g-co ers.

row f mall t th d m ts, th tl m l f t served th r so l ttle as a ınfern rface f tl ght m -c wl h l -c ll t th f m l s, gl t adly h und l th th and n u ed as th b n t ns fied th gh se u l sel t n by bow I bse ed th sam d m ta y t t re th und d l th ght wing-co *I have g rd m H ce w m y* f th co fid ce tl at th Loc tidæ d see l d from f m m wh ch as tl ıstı g Ach t dæ b th w g-co had se ted u th n d face d co ld be ınd ff re tly sed as th b w b t th t th Locust dæ th t w g-co rs grad ally bec m d ff t t d d pe fected th prın pl f th d f l bour tl to act el ly as tl bow and tl th as th fiddl D Grube t k th sam w and has sh w th t rudım n p eced g fam l Th ı n surface f the fem (fig 14) fur ıshed w th l gı t d l w f m t l gant, lan t h ped last c teeth from 8 to 93 ı n mb [30] and th se ar sc ped across tl h rp project g rvu s th w g-co s, wl ch re tl mad to b t d eso d H rrıs say

[28] West ood *Modern Clas ficat f Insects* 1. p 453

[29] La d ıs, *Zeıtsch ft f wıss nschaft. Zoolog* B xvııı. 1867 ss. 121 122.

that when one of the males begins to play he first bends the shank of the hind leg beneath the thigh where it is lodged in a furrow designed to receive it and then draws the leg briskly up and down He does not play both fiddles together but alternately first upon one and then on the other In many species the base of the abdomen is hollowed out into a great cavity which is believed to act as a resounding l

African ge

we meet w

tion in the males a small notched ridge projects obliquely from each side of the abdomen against which the hind femora are rubbed [2]

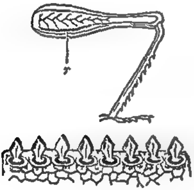


FIG 14 Hind l g f *Stenobothr s pr to m* r the t d l tng ridge l w figure the teeth f r i g the r dg uch mag fed (*from Lan l is*)

As the male is furnished with wings (the female being wingless) it is remarkable that the thighs are not rubbed in the usual manner against the wing-covers but this may perhaps be accounted for by the unusually small size of the hind legs I have not been able to examine the inner surface of the thighs which judging from analogy would be finely serrated The species of Pneumora have been more profoundly modified for the sake of stridulation than any other orthopterous insect for in the male the whole body has been converted into a musical instrument, being distended with air like a great pellucid bladder so as to increase the resonance Mr Trimen informs me that at the Cape of Good Hope these insects make a wonderful noise during the night.

In the three foregoing families the females are almost always destitute of an efficient musical apparatus But there are a f w excep tions to this rule for Dr Gruber has shewn that both sexes of *Ephippiger vitium* are thus

provided though the organs differ in the male and female to a certain extent. Hence we cannot suppose that they have been transferred from the male to the female as appears to

Locustidæ (but not, according to Landois, in Decticus) the females have rudiments of the

FIG 15 I i a (f t een na i the Br t I Mus um) Upper figure mal l r fgur f m le

stridulatory organs proper to the male from whom it is probable that these have been transferred Landois also found such rudiments on the under surface of the wing-covers of the female Achetidæ and on the femora of the female Acridiidæ In the Homoptera, also the females have the proper musical apparatus in a functionless state and we shall hereafter meet in other divisions of the animal kingdom with many instances of structures proper to the male being present in a rudimentary condition of the female

Landois has observed anoth important

[2] Westwood *Mod rn Classif at* I p 462.

fact, namely that in th females f th Acri didæ, the trid latin teeth n th f mora remain thro gh t lif in th sam cond t n in which th y first appear during th larval stat in both sexes. In th mal s, n th th hand they becom f rth r d loped and acquire their perfect truct re at the last moult, whe th insect is mature and ready t breed.

From th facts n w gi n we see th t th means b which the males of th Orthopt ra produce th ir sounds are xtrem l d rsified, and are alt g th diff re t from those em ployed b th H mopt ra.[a] B t throu h t the animal kingd m w ft n find the sam object gained by th mo t di rsified means thus seems d to th wh l o ganisat n h ing und rgo e m ltifarious changes n th course of ges, and as part aft part aried different ariati ns w re taken ad anta e f for th m g ral purpose Th d rsult of

fossil insect in th D man f rmat of N w Brun wick, which furnished w th th w ll-known trmpan m stridulating pparatus of th male Locustidæ Th insect, th gh in most respect related to th N uropt ra, p pears, as is so ften th case w th ry ancie t forms, t co ect th tw related Ord rs f the Neuropt ra and Orth pt ra.

I ha b t littl more to sa n th Orthoptera. Som of the pecies are ry p gnaci us ben tw male fi ld-crick ts (Gryllus campestris) are confined to th th fight till ne kil the ther and th species f mantis are described as manœ ri g w th thei sw rd lik fro t limbs, lik hussars w th th sabres. The Ch nese keep these insects in little bamboo cages, and match them lik gam -cocks.[a]

W th respect to col ur some exotic locusts are be tifully ornam nted th e po t rior wings being marked with red blue and black but as thro gh ut the Orde the sex s rarely diff r much in col ur it is n t probable that they w th r bri ht t ts t sexual select on Con p cu u colo rs m be f use to th se insects, by gi g n t ce th t th are unpalat able Th t has been observed[a] that a b ht coloured Indian locu t was in ariabl rejected wh n off red to birds and lizards. Some cases, howe are kn wn of sexual diff re res in colour thus Ord r The male of an Am rican crick t[a] is described as being as wh te as ry whilst th f male varies from almost whit t greenish y llow o d sky Mr Walsh inf rms m that th ad lt mal of Spectrum fem rat m (o e f th Phasmidæ) "is f si n ing brownish ell w colou th ad lt f m al bein f a d ll opaque cin reous brown the y g of both se es bein green. Lastl I may m t n that th mal f n curious kind f cri k t[a] is furnished w th a long m m branous ppendag which falls er th face lik il b t what ts use may be is n t kn wn.

Ord NEUROPTERA. —Little need h re be said e cept as t col In th Eph m ridæ th se es oft d ff sli htly in th bscure tints[a] b t t is not probable that th males are thus rend red ttract to the f mal s. Th Libell lidæ or dragon flies, are orna m nted with spl ndid green, bl ll w and rmili n m tallic tints and th sexes oft n diff Thus, as Prof W twood marks,[a] the males f som of th Agri idæ are of a rich bl w th black ings, whilst th f males are fin green with col urless wings." B t in Agrion ramburi these colours re xactly re rsed in th two sexes. In the ext n N Am rican g n f H tærina, the males alo e ha a bea tiful carmin pot t the base f

Landois has rece tly found in certai Orthoptera rud mentary structures close y similar t the sound-producing org ns in the Homoptera nd this is surprisin fact See Zeitschrift fur wissenschaft Zoolog B xx Heft 3 1871 p 348

Transactions Entomological Society 3rd series, vol ii. Journal of Proc of g p 117)

Westwood, Modern Classification of Insects, vol p 427 for chets p 445.

Mr Ch. Horne, Proceed g f th En mological Society M y 3 1869 p xii.

The Œcanthus alis Harris, Insect of New E gl nd, 1842, p. 124 The tw se es of Œ pellucidus of Europe differ as I hear from Vict Carus, n nearly th sam ma

Flat blemnus Westwood, Modern Class fica t n, ol ii., p. 447

B D Walsh, the Pseudo-neuropt ra of Illi nois, in Proceed of the Ent mological Society f Philadelph a, 1862, p 361

Modern Classification, vol p. 3

W lsh, ibid p.381 I am ndebted t this naturalist for the follo in f cts Hetæri a, Anax, and Gomphus.

each wing In *Anax junius* the basal part of the abdomen in the male is a vivid ultramarine blue and in the female grass green In the allied genus Gomphus on the other hand and in some other genera the sexes differ but little in colour In closely allied forms throughout the animal kingdom similar cases of the sexes differing greatly or ... t at all ... there is ... ie sexes ... it is often difficult to say which is the more brilliant and the ordinary coloration of the two sexes is reversed as we have just seen in one species of Agrion It is not probable that their colour in any ca e have been gained as a protection Mr MacLachlan who has closely attended to this family writes to me that dragon flies—the tyrants of the insect world—are the least liable of any insect to be attacked by birds or other enemies and he believes that their bright colours serve as a sexual attraction Certain dragon flies apparently are attracted by particular colours Mr Patterson observed [a] that the Agrionidæ of which the males are blue settled in numbers on the blue float of a fishing line whilst two other species were attracted by shining white colours

It is an interesting fact first noticed by Schelver that in several genera belonging to two sub families the males on first emergence from the pupal state are coloured exactly like the females but that their bodies in a short time assume a conspicuous milky blue tint owing to the exudation of a kind of oil soluble in ether and alcohol Mr MacLachlan believes that in the male of *Libellula depressa* this change of colour does not occur until nearly a fortnight after the metamorphosis when the sexes are ready to pair

Certain species of Neurothemis present according to Brauer [a] a curious case of dimorph ... in some of the females having ordinary wing whilst others have them ve y richly netted as in the males of the same pecies Brau r explains the phenomenon on Darwinian principles by the supposition that the close netting of the veins is a secondary sexual character in the males which has been abruptly transferred to some of the femal ... of as generally occur to all of them Mr MacLachlan informs me of another instance of dimorphism in several species of Agrion in which some individuals are of an orange colour and these are invariably females This is probably a case of reversion for in the true Libellulæ when the sexes differ in colour the females are orange or ... ters it would not be surprising that a tendency to vary in this manner should occur in the females alone

Although many dragon flies are large powerful and fierce insects the males have not been observed by Mr MacLachlan to fight together excepting as he believes in some of the smaller species of Agrion In another group in this Order namely the termites or white ants both sexes at the time of swarming may be seen running about the male after the female sometimes two chasing one female and contending with great eagerness who shall win the prize The *Atropos pulsatorius* is said to make a n i e with its jaws which is answered by other individuals [a]

Order HYMENOPTERA — That inimitable observer M Fabre [a] in describing the habits of Cerceris a wasp like insect remarks that fights frequently ensue between the males for the possession of some particular female who sits an apparently unconcerned beholder of the struggle for supremacy and when the victory is decided quietly flies away in company with the conqueror Westwood [a] says that the mal of on of the saw flies (Tenthredinæ) have been found fighting together with their mandibles locked As M Fabre speaks of the males of Cerceris striving to obtain a particular female it may be well to bear in mind that insects belonging to this Order have the power of recognising each other after long inter als ... and are deeply attached ... For instance ... Huber ... doubts ... separated some ... and ... after an interval of four months ... which had formerly belonged to the ... recognised ... and ... Had they been strangers ... would have fought together ...

[a] Transactions Ent Soc vol i 1836 p lxx

[a] See abstract in the *Zoological Record* for 1867 p 450

[a] ... by ... *Introduction to Entomology* ... 1818 ... p 104

... *Mental* ... *Nat Hist* ... *Review* ... 1862 p 122

... *Journal* ... Sept 7 1863 p 169 ... *Entomological Society*

in battl th ants n th same d sometimes ttack ach th r m th g al con fus n, b t they soo perce e the r mistake, and the ant sooth s th the [50]

In this Ord sl ht d ff rences n colour according t sex, are comm n but consp c s diff rences are rare except n tl f m ly of bees t both se es f ce tain gro p are so brilliantly col red—f instance Chry s, in wh ch mili n and metall c greens pre ail—th t w are t mpted t tt b t the result t sexual select n. In th Ichn um dæ according to M W lsh [51] the m les are almost ni rsally l ght r-colou ed than the f mal s. O th th hand tl T thred inidæ th mal ar g ally dark than the f males. I th S n dæ th se frequ tly diff th s th mal f S g e e is band ed with orang whilst th f mal dark p pl b t t is d ffi lt t sa wh ch se is th m re rn m ted I T em ol mbæ th f mal is m h bright col red than tl mal I am nf rmed by M F Sm th th t th mal anta f se ral pec are black, th f males bein t t ceo s.

I th family f bees, pecially in th sol

b as ll as Apath s, in ch m re arı bl in colo than tl f m l s. In A thoph ra d th mal s f a rich f l s-brow hilst th f mal is quit black so are th f males f se ral pec es f X locopa, th m l bei g bright y llow On th th hand th f mal f som speci s, as f A dren f l are m h bright col red than th males. Such diff re ces col hardl b co ted f t th mal being d f cel ss nd th req ri g prot ct hilst th f mal are ll d f nded b tl tings. H M ll [52] l has part cularl tt ded t th h b ts f bees ttrib tes these diff re ce in col ur in h f p rt to se ual select Th t bee h kee percepti f col is certain. H say tl t th m l search g l and fi ht f th po sess f th f mal and h account thro gh h co t t f th mandibl f th male be g in certai peci larg tl n tl se of tl f ial s. I som case tl m les re far m re m ro th th f mal s, th arly

in tl e season, o at all tim s and places, or locally wh reas the f male in the cases are appare tly n e cess In som peci s tl m re b a t f l m l s ppear to ha been lected by tl f mal and in thers th n re b auti f l fem le by tl e mal Consequ ntly in certain ge ra (Müll r p 4) th m le f the se al pec d ff m h i appear nce l l t tl f male e almost i di tinguisl

seg ts, d I fi d th t tl se urface are marked w th y fin co centri r dge b t so is th project g tl ac e collar int wl ch the h ad art l t s, and th collar wh n sc t l ed w th tl po t of a needl em ts tl e prope sound It is ther rprising th t both se h ld h e tl powe f trid l ti g as th male winged and tl f mal wingl ss. It n t n tl t bee p ss certain mo ti ns, as f ang by th t f th ir h m ming and cord g t H Müller (p 80) th mal f som pec es mak a pec l ar gi g n ise whilst pursuing th f m les.

m l bee f rt l sed by mal wh ch prese ted som

gr dl th Th acq irem t f w h ract rs by the t d w L bees is m ch m re d fficult ase b t l ha d ured t I w iny O g f Specie h these ter le be are bjected t th po er of tural selecti n.

[50] I ll be Recherch su le Mœu de Fourmis l l pp 150 165

[51] Proc ed g of the Ent molog al ociety f Philadelph 1866, pp 238, 239

[52] d g d Darw sche I hre uf B nen, Verh d n l Jah g ix

[53] Q ted by West ood Moder Classifi at f Insects L p 214

each wing. In *Anax junius* the basal part of the abdomen in the male is a vivid ultramarine blue, and in the female grass-green. In the allied genus Gomphus, on the other hand, and in some other genera, the sexes differ but little in colour. In closely allied forms throughout the animal kingdom, similar cases of the sexes differing greatly, or very little, or not at all, are of frequent occurrence. Although there is so wide a difference in colour between the sexes of many Libellulidæ, it is often difficult to say which is the more brilliant; and the ordinary coloration of the two sexes is reversed, as we have just seen, in one species of Agrion. It is not probable that their colours in any case have been gained as a protection. Mr. MacLachlan, who has closely attended to this family, writes to me that dragon-flies—the tyrants of the insect world—are the least liable of any insect to be attacked by birds or other enemies, and he believes that their bright colours serve as a sexual attraction. Certain dragon-flies apparently are attracted by particular colour: Mr. Patterson observed[52] that the Agrionidæ, of which the males are blue, settled in numbers on the blue float of a fishing line, whilst two other species were attracted by shining white colour.

It is an interesting fact, first noticed by Schelver, that, in several genera belonging to two sub-families, the males on first emergence from the pupal state are coloured exactly like the females; but that their bodies in a short time assume a conspicuous milky-blue tint, owing to the exudation of a kind of oil, soluble in ether and alcohol. Mr. MacLachlan believes that in the male of *Libellula depressa* this change of colour does not occur until nearly a fortnight after the metamorphosis, when the sexes are ready to pair.

Certain species of Neurothemis present, according to Brauer,[53] a curious case of dimorphism, some of the females having ordinary wings, whilst others have them "very richly netted, as in the males of the same species." Brauer explains the phenomenon on Darwinian principles by the supposition that the close netting of the veins is a secondary sexual character in the males, which has been abruptly transferred to some of the females, instead of, as generally occurs, to all of them. Mr. MacLachlan informs me of another instance of dimorphism in several species of Agrion, in which some individuals are of an orange colour, and these are invariably females. This is probably a case of reversion; for in the true Libellulæ, when the sexes differ in colour, the females are orange or yellow; so that supposing Agrion to be descended from some primordial form which resembled the typical Libellulæ in its sexual characters, it would not be surprising that a tendency to vary in this manner should occur in the females alone.

Although many dragon-flies are large, powerful, and fierce insects, the males have not been observed by Mr. MacLachlan to fight together, excepting, as he believes, in some of the smaller species of Agrion. In another group in this Order, namely, the termites or white ants, both sexes at the time of swarming may be seen running about, "the male after the female, sometimes two chasing one female, and contending with great eagerness who shall win the prize."[54] The *Atropos pulsatorius* is said to make a noise with its jaws, which is answered by other individuals.[55]

Order, Hymenoptera.—That inimitable observer, M. Fabre,[56] in describing the habits of Cerceris, a wasp-like insect, remarks that "fights frequently ensue between the males for the possession of some particular female, who sits an apparently unconcerned beholder of the struggle for supremacy, and when the victory is decided, quietly flies away in company with the conqueror." Westwood[57] says that the males of one of the saw-flies (Tenthredinæ) "have been found fighting together, with their mandibles locked." As M. Fabre speaks of the males of Cerceris striving to obtain a particular female, it may be well to bear in mind that insects belonging to this Order have the power of recognising each other after long intervals of time, and are deeply attached. For instance, Pierre Huber, whose accuracy no one doubts, separated some ants, and when, after an interval of four months, they met others which had formerly belonged to the same community, they recognised and caressed one another with their antennæ. Had they been strangers they would have fought together. Again, when two communities en[illegible]e

[52] *Transactions Ent. Soc.*, vol. i., 1836, p. lxxxi.

[53] See abstract in the *Zoological Record* for 1867, p. 450.

[54] Kirby and Spence, *Introduction to Entomology*, vol. [illegible] 1818, p. [illegible]

[55] Houzeau, *Études* [illegible] *Les Facultés Mentales des* [illegible] tom. [illegible] p. 104.

[56] See [illegible] in [illegible]

[57] *Journal* [illegible] Sept. [illegible] 1863, p. 169.

in battle, the ants on th sam de sometimes ttack ach oth r in th neral con fusion, b t they soon perce th ir mistak and the n ant sooth th oth

In this Order sh ht d ff re ces in col ur according t sex, are comm n, b t consp u u diff re ces are rare cept in th family f bees t both se es f certain group ar so b illiantly col ured—f instance n Chrys s, in wh ch rmilio and m talli greens pre vail—that we ar tempted to ttribute th result to sexual selecti n. In th I hne m n dæ according to Mr Walsh[15] tl m l are almo t n rsall li ht -coloured than tl f males. O th th hand, in th T nthred nidæ th males are g rally darke tl an tl f males. In the S ricidæ th se frequ tly differ th th mal f S j en s band ed with range whilst tl femal is d k p ple b t t is diff lt t sa which sex th m re rnam ted I T emex ol mba tl f male is m h bright col ured than the male I am inf rmed b M F Smith, th t th mal ants f se l pec are black, th f males bein testaceous.

I th family f bees, especially in th sol tary peci s, as I hea from th sam n tom logist, th se ft diff in colo Th males are g rally th bright and in B m bus as ll as in Apath s, in h m ariabl in col than th f mal s. I A thopho a th mal is f n h ful s-brown hil t the f ma is q t black so are th f males f se eral pec es f X locopa, th males being bright ll w On th ther hand th f mal f som spec s, as f A d ana f l a, are m h bright col red than th mal s. Such diff rences col ca hardl b ac co ted f b tl m l be g d f cel ss and th req ring prot et ist th f mal are ll l f nd d t tl tings. H Mull ho has part cula l tt ded t th h b t f bees, ttrib t these diff rence in col m ch f part to se ual select That bee ha kee percepti f col is certain. H says that th mal se rch eag l and fi ht f th possess f th f males and h accounts thro gh h co te t f th mand bl f th males be ng in certai peci larg than th se of tl f male In som cases tl males are far more m ro tha th f males, th arly in th season r at ll tim s and places, or l r s th f male n othe cases are

ful f mal by th male C nsequent u certain g ra (M ller p 4) th male of the se e al pec es d ffe m h n appear ce whil t th f males re alm t distingu h Il n th g ra the re erse occu s. H Mull beli e (p 8) that tl col urs gained by e sex thr gh se ual selecti n ha often bee n ll d rree to the ll

t

th mas t w m

M t lla E pea makes a tr d lating n ise and accord g to G re u[16] both se es l a th pow H attrib t the so d to the f t f tl third and preced g abd m al

th l ad art l t and this collar wl n scrat hed w th th po t f a needl m ts tl e prope sound It rath r rprising that both se e sh ld ha th pow f tridulati g as th m l is w ged and tl f mal wingless. It is tori that bee press certain mo ti ns, as of ang by th t n f th hum ming and accord g to H Mull r (p 80) th mal s f som peci make pecul ging noise whilst p g th f mal s.

m l bee f rtilised b male, h h prese ted som

gr ll th Th acquirem t of w h ra t rs by the t rd w ker bees is m ch m re difficult case b t I ha dea ured to sh w my O g f Specie h w these terile be gs are ubjected t th power of natural selecti n.

[15] Q ted by West ood Moder Classifi atio f Insects l p 214

I H ber Recherche le Mœu d Fourmis 181 pp 150 165

I oceed g of the Entomolog al Society f Philadelphia, 1866 pp 238, 239

[16] An dung der Darw sche Lehre uf B enen, Verh d n. J Jahrg xix.

Order COLEOPTERA (Beetles).—Many beetles are coloured so as to resemble the surfaces which they habitually frequent and they thus escape detection by their enemies Other species for instance diamond beetles are ornamented with splendid colours which are often arranged in stripes spots crosses and other elegant patterns Such colours can hardly serve directly as a protection except in the case of certain flower feeding species but they may serve as a warning or means of recognition on the same principle as the phosphorescence of the glow worm As with beetles the colours of the two sexes are generally alike we have no evidence that they have been gained through sexual selection but this is at least possible for they have been developed in one sex and then transferred to the other and this view is even in some degree probable in those groups which possess other well marked secondary sexual characters Blind beetles which cannot of course behold each other s beauty never as I hear from Mr Waterhouse jr exhibit bright colours though they often have polished coats but the explanation of their obscurity may be that they generally inhabit caves and other obscure stations

Some longicorns especially certain Prionidæ offer an exception to the rule that the sexes of beetles do not differ in colour Most of these insects are large and splendidly coloured The males in the genus Pyrodes [43] which I saw in Mr Bates s collection are generally redder but rather duller than the females the latter being coloured of a more or less splendid golden green On the other hand in one species the male is golden green the female being richly tinted with red and purple In the genus Esmeralda the sexes differ so greatly in colour that they have been ranked

as distinct species in one species both are of a beautiful shining green but the male has a red thorax On the whole as far as I could judge the females of those Prionidæ in which the sexes differ are coloured more richly than the males and this does not accord with the common rule in regard to colour when acquired through sexual selection

A most remarkable distinction between the sexes of many beetles is presented by the great horns which rise from the head thorax and clypeus of the males and in some few cases from the under surface of the body These horns in the great family of the lamellicorns, resemble those of various quadrupeds such as stags rhinoceroses &c. and are wonderful both from their size and diversified shapes.

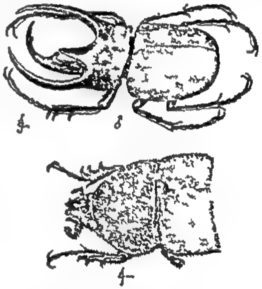


FIG 16 *Chal... atl...* Upper figure ... le (reduced) lower figure f... ale (... ze)

Instead of describing them I have given figures of the males and females of some of the more remarkable forms. (Figs. 16 to ...0) The females generally exhibit r... ...

... other hand the horns are nearly as well developed in the female as in the male ... *Phanæus lancifer* and only a little less well developed in the females of some other species of this genus and of Copris I am informed by Mr Bates that the horns do not differ in any manner corresponding with the more important characters the differences between the several subdivisions of the family thus within the same section of the genus Onthophagus,

up ... r ... in ... e

... in ... x s f b etl s h by nd Sp... ce (*I nt od ... t ... E t mol g ...* ... p 301) m nt ... a C ... rs, M loe Rh g m a ... th *Lept a t ...* th m ... f tle ... be g ts ... t cou ... th bl ck tl ... d th f ... f a d ll ed ... Il ese t ... beetl b ... g to the f ... ly of ... g co ns. M ... s. R. ... d W ... r s, ... r ... m ... as I ...

F G. 17 C pr nsud (Left h d figures, mal s.)

Fi 18 Ph nau f

F 19 D pel eu t rs

I 20 O ul ph g g f l ged.

th re are peci wl ch l gl l rn and th l h h t

I lm t all case th l rn are m kabl f tl cess ariab l ty so that g ad ted se es can be f rmed f m tl m t l ll d l ped m l t th so d g t tl t th y can b rely b distingui l ed from th f al M W lsl f d th t in I h m f tl h w re thr ce as l g in som mal th M B tes, aft g abo h dred mal f O tho- y fer (fig 20) tl gl t tl t h had t last disco red pec m wl l th h rns l l t r b t f rtl researcl pro ed tl m trar

The ext aord ary size f th h rns, and th w d ly d ff rent tructu m l sely all ed f ms, indicate that they ha been f rmed f some purpose b t th ir excess e ari b l ty in th males f th same peci l ad t th nf rence th t tl purpose cann t b f d fimt nat re Th h rns do not how marks of fri t as if used f any rdin ry w k Som utl ppose th t as th mal wand abo t m ch m re than th f mal s, tl y equire h rn as d f ce gain t th m b t as th horns are ft n bl t th y d n t seem w ll ad pted f def ce The m t b co jecture is th t th y are used by th m l f r fighti g tog th b t th

Proceed g f the Ent olog l Society f Ph l delphia, 1864 p 228

h by d pe ce Int od t to Ent mology l. p. 300

males have never been observed to fight nor could Mr Bates after a careful examination of numerous species find any sufficient evidence in their mutilated or broken condition of their having been thus used If the males had been habitual fighters the size of their bodies would probably have been increased through sexual selection so as to have exceeded that of the females but Mr Bates after comparing the two sexes in above a hundred species of the Copridæ did not find any marked difference in this respect amongst well developed individuals In Lethrus moreover a beetle belonging to the same great division of the lamellicorns the males are known to fight but are not provided with horns though their mandibles are much larger than those of the female

Fig 21 *On t f ref* mal iewed fr m [illegible] ne th

The conclusion that the horns have been acquired as ornaments is that which best agrees with the fact of [illegible] been so [illegible] ed —as [illegible] ie same [illegible] and by their extreme diversity in closely allied species This view will at first appear extremely improbable but we shall hereafter find with many animals standing much higher in the scale namely fishes amphibians reptiles and birds that various kinds of crests knobs horns and combs have been developed apparently for this sole purpose

The males of *Onitus furcifer* (fig 21) and of some other species of the genus are furnished with singular projections on their anterior femora and with a great fork or pair of horns on the lower surface of the thorax Judging from other insects these may aid the male in clinging to the female Although the males have not even a trace of a horn on the upper surface of the body yet the females plainly exhibit a rudiment of a single horn on the head (fig 22 *a*) and of a crest (*b*) on the thorax That the slight thoracic crest in the female is a rudiment of a projection proper to the male though entirely abs [illegible] ns [illegible] of [illegible] [illegible] ilar slight crest on the thorax and the male bears a great projection in the same situation So again there can hardly be a doubt that the little point (*a*) on the head of the female *Onitis furcifer* as well as on the head of the females of two or three allied species is a rudimentary representative of the cephalic horn which is common to the males of so many lamellicorn beetles as in Phanæus (fig 18)

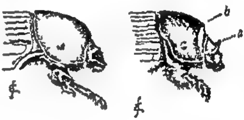


Fig [illegible] t f [illegible] ure le- Trace [illegible] c l re t

The old belief that rudiments have been created to complete the scheme of nature is here so far from holding good that we have a complete inversion of the ordinary state of things in the family We may reasonably suspect that the males originally bore horns and transferred them to the females in a rudimentary condition as in so many other lamellicorns Why the males subsequently lost their horns we know not but this may have been caused through the principle of compensation owing to the development of the large horns and projections on the lower surface and as these are confined to the males the rudiments of the upper horns on the females would not have been thus obliterated

The cases hitherto given refer to the lamellicorns but the males of some few other beetles belonging to two widely distinct groups namely the Curculionidæ and Staphylinidæ are furnished with horns—in the former on the lower surface of the body [illegible] in the latte [illegible] ad and [illegible] of the [illegible] e same [illegible] just as we have seen with the lamelli

[illegible] by d pe ce *I ul od ct to E t mology* 1 [illegible] 329

corns. In Siagonium w ha s a case of di morphism, f the males an be di aled int two sets, diff ring gre tl in the size f th bodies and in th d lopment f th ir l rns, without intermediate grad tions. In a species

FIG. 23 Bled us taurus, magnified. Left hand figure male right hand figure female.

of Bledi s (fig. 23) also bel nging to th Staph linidæ Professo Westwood tates that male pecimen can be f und in th sam localit in hich th central h rn of th thorax is ery larg b t th h rns f th head q t rudime tal and th rs, in whi h th th racic horn is m h short whil t th protubera ces on th h ad are l g W H re w ppare tly ha case of compensation, wi h throw light that j t g n, f th pposed loss f th ppe horns b th males f O tus.

Law f Battle —Som mal beetl s, wh ch seem ill-fitted f fightı g, ne rth less gage in conflicts fo th possess f th f males. M Wallace[s] saw tw mal f *Lepto hynchus ang status* lin ar beetle w th much lo gated *rostrum* figl ting f a f mal wh tood lose b bu, t h boring Th y pushed at each th with th ir ro tra, and lawed and thumped ppare tly in th gre t t rag The maller male h w soon an w acknowledgı himself anquished In som f w cases mal beetles are w ll ad pted f

from th p pal tat abo t week bef re th the sex, so that se ral may ften be seen pursuing th sam f male At this seaso th y en, g in fi rce conflicts. Wh M A H. B s nclosed tw mal with f mal in box, the lar male se rely p nched th maller o until he resigned his pretens ons. A fri nd inf rms m that wh n a bo he often g t th males t th r t see th m fight, and he not ced that th w re m ch bold and fi rce than tl females, as u th tl h gh ani mals. Tl males would seız h ld f his fing if h ld n fro t f th m b t n t so the f mal s, alth gl th h tro g j ws. The males of many of the Lucanidæ as w ll as of the abo m nti ned Lep- t h n h s, are larg r an f m re pow rf l insects than th fe males. Th tw sexes f *Lethrus phalot s* (on f the lamellicorns) inhab t the sam b rrow and th mal has larg r mandibles than th f m l If during th breeding season, a trange

lam llicorn beetl the *Ateu hus cicatricosus* li pairs, and seem much attached to ch th th male xcites th f males to roll th

are trem l ariabl both in size and truc- ture and in this respect resembl th horns n th h ad and th rax f many male lam lli corns and Staph linidæ A perfect seri s can be f rmed from th best provided to the worst pro ided o d g rat males. Alth gh the mand bles f th comm n tag beetl and probably f many th speci s, are used as ef fi t weapons f fighting, t is do btf l wh th th ir gre t size can thus be accounted f W ha seen that th y are used by th *L us lapkus* of N Am rica f seizing th f mal As th y are so con p cu us and so ele- gantl branched and as owing to thei gre l gth th y are n t w ll ad pted f pinching, the u p ci n has rossed my mind that th y may in additi n serv as an ornam nt, lik th h rns th head and th rax of th ari us peci abo described. Th male Chiasog a-

Modern Classification of I ects ol. i., p. 1 2 Siagonium, p 1 2. 1 the British Museum I tced one male specime of Siagonium termediat nd son so that the dimorphism is not trict.

[s] The Malay Arch pelago, ol. ii. 1869 p. 276. Riley th I port on Ins cts f Misso ri, 1b 3 p. 115

Entomological M gazine vol. i., 1833 p 82. See also the conflicts of this species, Kirby d pence ibid., vol. iii., p. 314 d West ood, ibid., ol. i., p. 187

Quoted from Fischer in *Dict. Class. d'Hist. Nat.*, tom. p. 324

A n. Soc Ent mology F nce 1866 as quoted in *Journal of T* d by A. Murray 1868, p. 135

thus granti of S Chile—a splendid beetle belonging to the same family—has enormously developed mandible (fig 24) he is bold and pugnacious when threatened he faces round

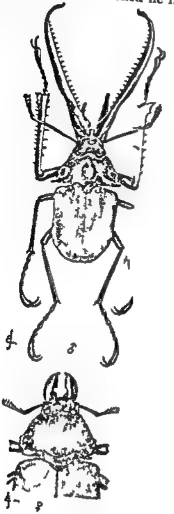


FIG 24 *Cl a gn thu gr nt* red ced Upp r figure male lo figure f m l

opens l

ie
t
e

Sexual selection which implies the possession of considerable perceptive powers and of strong passions se ms to have been more effective with the lamellicorns than with any other family of beetles With some species the males are provided with weapons for fighting some live in pairs and show mutual affection many have the power of stridulating when excited many are furnished with the most extraordinary horns apparently for the sake of ornament and some which are diurnal in their habits are gorgeously coloured Lastly several of the largest beetles in the world belong to this family which was placed by Linneus and Fabricius as the head of the Order

Stridulating organs —Beetles belonging to many and widely distinct families possess these organs The sound thus produced can sometimes be heard at the distance of several feet or even yards but it is not comparable with that made by the Orthoptera. The rasp generally consists of a narrow slightly raised surface crossed by very fine parallel ribs, sometimes so fine as to cause iridescent colours and having a very elegant appearance under the microscope In some cases as with Typhœus minute bristly or scale like prominences with which the whole surrounding surface is covered in approximately parallel lines could be traced passing into the ribs of the rasp The transition takes place by their becoming confluent and straight and at the same time more prominent and smooth A hard ridge on an adjoining part of the body serves as the scraper for the rasp but this scraper in some cases has been specially modified for the purpo e It is rapidly moved across the rasp or conver ely the rasp across the scraper

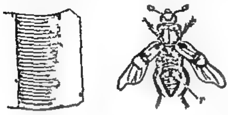
po

twe rasps (r fig 2) stand on the dorsal surface of the fifth abdominal segment each rasp consisting of 126 to 140 fine ribs. These ribs are scraped against the posterior margins of the elytra a small portion of which projects beyond the general outline In many Crioceridæ and in *Clythra 4 punctata* (one of the Chrysomelidæ) and in some Tenebrionidæ &c the rasp is seated on the dorsal apex of the abdomen

On (t Mus cal (urcul 181 ... 1860 p ... La d is, *Zeit h ft f ... sch ft Zoolog* 1867 127

... I bt d t M C B ... Clyth ... I bted t Mr J W J ... bser ed ... *D m st m* ... sc rel ed ... but ... *Ent logi t M thly M g ne* ... 130

an th family th rasps are placed on th les f the first bd minal gm t, and are scraped by ridg n tl f m a. In c t C rculi dæ and Car b dæ[77] th parts are compl t ly r sed po t n f r the asp re se ted th nf n rface f th elytra, near th p ces, r al g tl r te margins,



F G. 25 N cr ph rus (f m La d is) Th t raspa. Left ha d figure part of th ra.p highly m g fied

and th edg f tl abd minal gm ts erve as tl e scrapers. In *H lob H rma s* (f D tusci læ w t b tl) tro g dge ns parall l and to th tural margin f tl lytra, and is crossed by rib co m in the

F G. 26 Hind l g f *G ot pe stercor rius* (from Land) Ra.p C f Femur t Tb t T rs

m l ll part b t becom g g ad ally fi t both nds, pe ally t th ppe d wh n tl insect is h ld d t m th air

asps th lytra.

t id l t g n s e s prod ced by tl e c trem h rus m rgin of tl e abd m n bei g sc aped gainst ll a.ps In gre t number of l ng h r ed beetles (Longicorni) th rg n are situ ted qu te tl rw se the rasp b i g n th m so-tho wh l m rubbed g inst tl e pro-th ax Lar do cou ted 238 very fine ribs on th rasp of *Cer mby l os*

Many lamelli c r s l the power of trid ulating, and the gan differ greatly n pos t Som peci trid l te v e y l udly so

nal segm nt In th ly all d *C prt l* n an ces. t lv n rrow fin ra.p r n al ng th utural ma gin f th elytra, th another l rt a.p near th basal uter margin but n som th C p in th a.p se ted accord ing to Leconte[78] on the d al s rface of the abd m In O t s it is se t d on tl e pro-py d um d according to the same ent m l gi t, n some th r Dynast s on tl e un de s rface f th lyt Lastly W tring states th t n *Omalopl bru ea* the asp is placed n th p o- t rnum a d th scrap r n th m ta t rn m th p ts thu occ p g th u d fac f tl e body in tead f the uppe u face as the Lo gicorns

W th s see th t in tl diff rent colept famil th strid lati g gans are w le fully d rs fied po t n b t n t m h in tru ture W thin th sam fam ly some spe cies re p ded n th th o gans, nd tl rs are l t tut f them. Th d rs ty t l l g bl if w ppose tl t n lly v beetl mad a shuffling or h ssing se by th rubbin tog tl f any hard and r gh p rt of th bod s, wh h h ppe ed to be in co tact d that from tl n se th p od ced b ing n som w y sef l the ro gl face wer grad ally d l ped nto regular tridu lating gans. Som beetl as th y m n w prod ce th int ti ally int nt n ally a sl ffling n ise w tho t po se any prope gan f th purpose Mr Wallace inf rms me th t the *E h rus lo g m* (a lam ll corn w th th ant r l gs wond

[77] W chi lt tr nsl ted, *A al nd M gazine f Nat Ill History* L 1867 p 37
[78] West g ha described (*Mod r Ci lasi*

[79] I m d bted t M Walsh f Illi s, f h g se t m t ts f m Leco t *Int od c-tio to Ent ology* pp 101 143

fully elongated in the male) makes whilst moving a low hissing sound by the protrusion and contraction of the abdomen and when seized it produces a grating sound by rubbing its hind legs against the e lo

. . . by rubbing the shagreened surface of the femur against the granulated margin of the corresponding elytron but I could not here detect any proper

. . . has written about this beetle it seems very doubtful whether it possesses any true rasp though it has the power of emitting a sound

From the analogy of the Orthoptera and Homoptera I expected to find the stridulating organs in the Coleoptera differing according to sex but Landois who has carefully examined several species observed no such difference nor did Westring nor did Mr G R Crotch in preparing the many specimens which he had the kindness to send me Any difference in these organs if slight would however be difficult to detect on account of their great variability Thus in the first pair of specimens of Necrophorus humator and of Pelobius which I examined the rasp was considerably larger in the male than in the female

. . . prominent in three males than in the same number of females in order therefore to discover *whether the sexes differed in their* power of stridulating my son Mr F Darwin collected fifty seven living specimens which he separated into two lots according as they made a greater or less noise when held in the same manner He then examined all these specimens and found that the males were very nearly in the same proportion to the females in both the lots Mr F Smith has kept alive numerous specimens of *Monoynchus pseudacori* (Curculionidæ) and is convinced that both sexes stridulate and apparently in an equal degree

Nevertheless the power of stridulating is certainly a sexual character in some few Coleoptera Mr Crotch discovered that the males alone of two species of Heliopathes (Tenebrionidæ) possess stridulating organs I examined five males of *H gibbus* and in all these there was a well-developed rasp partially divided into two on the dorsal surface of the terminal abdominal segment whilst in the same number of females there was not even a rudiment of the rasp the membrane of this segment being transparent and much thinner than in the male In *H cribratostriatus* the male has a similar rasp excepting that it is not partially divided into two portions, and the female is completely destitute of this organ the male in addition has on the ap . . .

resembling those on the abdominal rasp whether these ridges serve as an independent rasp or as a scraper for the abdominal rasp I could not decide the female exhibits no trace of this latter structure

Again in three species of the lam . . .

but the chief difference is that the whole upper surface of this segment when held in the proper light is seen to be clothed with hairs, which are absent or are represented by excessively fine down in the males It should be noticed that in all Coleoptera the effective part of the rasp is destitute of hairs In *O senegalensis* the difference between the sexes is more strongly marked and this is best seen when the proper abdominal segment is cleaned and viewed as a transparent object In the female the whole surface is covered with little separate crests bearing spines whilst in the male these crests *in proceeding towards the apex* become more and more confluent regular and naked so that three fourths of the segment is covered with extremely fine parallel ribs which are quite absent in the female In the females, however of all three species of Oryctes, a slight grating or stridulating sound is produced when the abdomen of a softened specimen is pushed backwards and forwards

In the case of the Heliopathes and Oryctes

. . . can . . .

cape by strikin th h llow t ms of trees in the Canary Islands, Messrs. W llaston and Crotch w re abl to disco th presence of beetles bel ging to the g n Acall s by th ir strid lati n. La tly th mal Ate h s trid lates t ncoura the f mal n h r w k, and from distress wh he is rem ed [2] Som naturalists belie that beetles make th se to f ghten w y th e mies but I cann t think that q adruped b rd abl t d larg beetle, w uld b fri ht ed by so l bt sound Th beli f tl t tl tr d lat serv s as sexual call is pported by th fact th t death-ticks (A b m t llat m) are w ll kn n to answ ach th t cki g and as found h n ted with a m l and on o occas urrounded by sev ral males Finally it is prob ble th t th two sexes of many kinds f beetles w re at first bled to find each ther by th l gh l ffling no se produced by the rubbing t th of th adj n g hard parts f their bodies and that as tl ose m les or f mal s wl ch m de the g t t n se su ceeded be t n finding partn rs, rug iti on vari part of th r bod es w re grad ally d l ped by m ans of exual sele t on into true strid lati g gans.

duced by th sect ra g tself ts l g as h gh as t ca d th triki g ia th ra fi

M P d la Brul as q ted J rnal f T d, A. Murray L t., 1868, p 135

According to Mr D bleday th se is produced by th l m l d P m l trial prod ces rath l ud so d by tr ki g l bd m g nst) hard b ta ce d th t th m l obed t t this call, soo tt d h d they pair

CHAPTER XI

INSECTS *Continued*—ORDER LEPIDOPTERA

BUTTERFLIES AND MOTHS

I ... ng points ... ween the ... same species and between the distinct species of the same genus Nearly the whole of the following chapter will be devoted to this subject but I will first make a few remarks on one or two other points Several males may often be seen pursuing and crowding round the same female Their courtship appears to be a prolonged affair for I have frequently watched one or more males pirouetting round a female until I was tired without seeing the end of the courtship Mr A G Butler also informs me that he has several times watched a male courting a female for a full quarter of an hour but she pertinaciously refused him and at last settled on the ground and closed her wings so as to escape from his addresses

Although butterflies are weak and fragile creatures they are pugnacious and an emperor butterfly[1] has been captured with the tips of its wings broken from a conflict with another male Mr Collingwood in speaking of the frequent battles between the butterflies of Borneo says They whirl round each other with the greatest rapidity and appear to be incited by the greatest ferocity

The *Ageronia feronia* makes a noise like that produced by a toothed wheel passing under a spring catch and which can be heard at the distance of several yards I noticed this sound at Rio de Janeiro only when two of these butterflies were chasing each other in an irregular course so that it is probably made during the courtship of the sexes

Some moths also produce sounds for instance the males of *Theocopho a fo ca* On two occasions Mr F B ...) ... as ... Cicada by an elastic membrane furnished with a muscle He quotes, also Guenee that Setina produces a sound like the ticking of a watch apparently by the aid of two large tympaniform vesicles, situated in the pectoral region and these are much more developed in the male than in the female Hence the sound producing or an in the Lepidoptera appear to stand in some relation with the sexual functions I have not alluded to the well known noise made by the death s head sphinx for it is generally heard soon after the moth has emerged from its cocoon

Giard has always observed that the musky odour which is emitted by two species of sphinx moths is peculiar to the males and in the higher classes we shall meet with many instances of the males alone being odoriferous

Every one must have admired the extreme beauty of many butterflies and of some moths and it may be asked are their colours and diversified patterns the result of the direct action of the physical conditions to which these insects have been exposed without any benefit being thus derived Or have successive variations been accumulated and determined as a protection or for some unknown purpose or that one sex may be attract ... t ... ... es of the same genus Before attempting to answer the questions a body of facts must be given

With our beautiful English butterflies the admiral peacock and painted lady (Vanessae) as well as many others the sexes are alike This is also the case with the magnificent Heliconidae and most of the Danaidae in the tropics But in certain other tropical groups and in some of our English butterflies as the purple emperor orange tip &c (*Apatura iris* and *Anthocharis cardamines*) the sexes differ either greatly or slightly in colour No lan

[1] *Apat r ... ri* The *E t mol g t W e kly Intelligence* 1859 p 139 For the Bornean butterflies see C Collingwood *Rambles of a Naturalist* 1868 p 183

See my *J r l f R ... h* 1845 p 33 Mr Doubleday has detected (*Proc Ent Soc* March 3 1845 p 123) a pecul r m mb ... sa t th ba. f the fro t w gs, h ch prob bly co t ect ... th the prod ct n f th sou d ... r th ca ... f *Thecophora*, see *Zool gical Record* 1869 p 401 F ... Mr B char ... Wh t ... b rs t s, th *Scott h N t ... alist* July 18 2 p 214

[?] ... *Scott h Nat ... l t d ...* 18 ... p 213 *Zool g ... I I ... t* 1869 p 347

guage suffices to d scrib th spl nd u of the males of som trop cal pecies. E n w th n th sam g nus w ft n find peci prese t ing extraordinary diff re ces b tween the sexes, hilst oth s h th r sex closely I Th n th So th Am can g nu Ep

f ulus
Iu tw l e pecies, th tw sex f wh h

species the males rank am g t the mo t bril liant f all b tt rfl s, and d ff so gre tly from th compar ti ly plai f m l tl at they w re f rm rly placed d t ct e ra. Th females f th se n pec resembl each th in th ir g al t pe f col t and tl ey lik wise re mble b th sex f th species se e al allied g ra f d n ri ou parts f th w ld H ce w m f that these nin peci s, and probabl ll th th ra f th g s, are lesce ded from an ancestral f rm wl ch was colo ed n n arly the sam mann I th tenth spec th fe m l still retains th sam g al l ring, b t th mal resembles h so th t l col ured m l l ss g d ar d co t asted mann tha the males f the p n peci s. In tl l th an l t llth pec s, th f mal l p rt from tl al type f th y are gaily deco ted lmost lik th mal s, b t n som what less d gre H ce in tl se t l t le peci th b ght col rs f th m les seem to ha bee tra f rred t th f m l wl l t in tl tenth pec tl mal l as th re tained reco red th pl col rs f the fe mal as ll as f th par t f m of th g us. Th se es in these tl ree case ha th bee rendered arly alik th gh in an p posite man In tl lled g Eub gis, both se f som f tl peci are plai colo red and early al k l lst w th th gre te mbe tl mal re deco ted with bea tif l m tall tint d rsified mann and diff m ch from tl f mal Th fe male thro gh t tl g retain th sam g ie l t l f col uri g, so th t th y resem ble anoth m l m l sely than tl y rese l le the w mal

In the genus Pap lio, all the species of the Æneas gro p are remarkable for the r conspic u us and strongly co trasted col u s, an l tl y ill st ate tl frequ t tend ncy to grad t on m i t f diff re ce b twee tl sex s.

th species re embl each ther an i re ue t t te f ch colo rs, et in ce tain spec s,

Engl h bl b tt fl es f th gen I y ena ll trate the ar l ff rences in col ur be tween tl se s, alm t as w ll tho gh t i so trik g mann as tl e bove ex ti g n ra. In *Ly r g tis* b tl se s l e w gs f a brown col u b rd ed w tl mall ocell ted ang pots, and re tl u like In *L arg* tl wings f th m l are f fin blue b rd red w th black, wl l t tl se of th femal are brown w tl m lar bord clos ly sem bling th w gs f *L g l* Lastly n *L ari* botl se s re f bl col u and ar ry lik th gh th f mal th edges of tl e wings are th du ki with th black pot plain and n a bri ht bl e Ind n spec botl sex are still m re alik

I h g n tl f reg ing d tails in rd I w n th first place that wh n th se f butt rfl d ff tl e mal as g n al rul th m re b tiful and d parts m re fro th us al t pe f col g f the gro p t wh i the species bel g H nce n m t gro ps tl f mal f th se ral pec res mbl cl th m h m re closely than d tl mal In som ases, I w to wh h I hall h re ft all d th f m les are col d m re spl n d dly than tl males. In th seco d pla e th se d tails ha been gi n t b g clea ly bef re tl ind th t th n th sam g n th two se freq ntly prese t ry g ad

See lso M B tes pape P oc. Ent. Soc f Philadelph a, 1865, p 2 6 Also M W llace th same subject, regard t Diad ma, *Transactions* *E t mological Society* Lond n, 1869 p 2 8.

tion from no difference in colour to so great a difference that it was long before the two were placed by entomologists in the same genus. In the third place, we have seen that when the sexes nearly resemble each other, this appears due either to the male having transferred his colours to the female, or to the male having retained, or perhaps recovered, the primordial colours of the group. It also deserves notice that in those groups in which the sexes differ, the females usually somewhat resemble the males, so that when the m [...] beautiful to [...] ales almost [...] auty. From [...] e amount of [...] ference between the sexes, and from the prevalence of the same general type of coloration throughout the whole of the same group, we may conclude that the causes have generally been the same which have determined the brilliant colouring of the males alone of some species, and of both sexes of other species.

As so many gorgeous butterflies inhabit the tropics, it has often been supposed that they owe their colours to the great heat and moisture of these zones; but Mr. Bates[6] has shown by the comparison of various closely allied groups of insects from the temperate and tropical regions, that this view cannot be maintained; and the evidence becomes conclusive when brilliantly coloured males and plain coloured females of the same species inhabit the same district, feed on the same food, and follow exactly the same habits of life. Even when the sexes resemble each other, we can hardly believe that their brilliant and beautifully arranged colours are the purposeless result of the nature of the tissues and of the action of the surrounding conditions.

With animals of all kinds, whenever colour has been modified for some special purpose, this has been, as far as we can judge, either for direct or indirect protection, or as an attraction between the sexes. With many species of butterflies the upper surfaces of the wings are obscure; and this in all probability leads to their escaping observation and danger. But butterflies would be particularly liable to be attacked by their enemies when at rest; and most kinds whilst resting raise their wings vertically over their backs, so that the lower surface alone is exposed to view. Hence it is this side which is often coloured so as to imitate the objects on which these insects commonly rest. Dr. Rössler, I believe, first noticed the similarity of the closed wings of certain Vanessae and other butterflies to the bark of trees. Many analogous and striking facts could be given. The most interesting one is that recorded by Mr. Wallace[7] of a common Indian and Sumatran butterfly (Kallima), which disappears like magic when it settles on a bush; for it hides its head and antennae between its closed wings, which in form, colour and veining cannot be distinguished from a withered leaf with its footstalk. In some other cases the lower surfaces of the wings are brilliantly coloured, and yet are protective; thus in *Thecla rubi* the wings when closed are of an emerald green, and resemble the young leaves of the bramble, on which [...]

[...] colour on their upper surface, the lower surface is closely similar or identical in both sexes, and serves as a protection.[8]

Although the obscure tints both of the upper and under sides of many butterflies no doubt serve to conceal them, yet we cannot extend this view to the brilliant and conspicuous colours on the upper surface of such species as our admiral and peacock Vanessae, our white cabbage butterflies (Pieris), or the great swallow-tail Papilio which haunts the open fens—for these butterflies are thus rendered visible to every living creature. In these species both sexes are alike; but in the common brimstone butterfly (*Gonepteryx rhamni*) the male is of an intense yellow, whilst the female is much paler; and in the orange-tip (*Anthocharis cardamines*) the males alone have their wings tipped with bright orange. Both the males and females in these cases are conspicuous, and it is not credible that their difference in colour should stand in any relation to ordinary protection. Prof. Weismann remarks,[9] that the female of one of the Lycaenae expands her brown wings when she settles on the ground, and is then almost invisible; the male, on the other hand, as if aware of the danger incurred from the bright blue of the upper surface of his wings, rests with them closed; and this shows that the blue colour cannot be in any way protective. Nevertheless, it is probable that conspicuous colours are indirectly beneficial to

[6] *The Naturalist on the Amazons*, vol. i, 1863, p. 19.

[7] See the interesting article in the *Westminster Review*, July 1867, p. 10. A woodcut of the Kallima is given by Mr. Wallace in *Hardwicke's Science Gossip*, September 1867, p. 196.

[8] Mr. G. Fraser, in *Nature*, April 1871, p. 489.

[9] *Einfluss der Isolirung auf die Artbildung*, 1872, p. 58.

man species, as a warning th t th y are u palatabl F in certain th cases, b ty has bee gained thro gh th mitat f tl er bea tiful pec es, h ch nhab t the same d s-trict and j y an immunity from attack by being in som w y ff si to th ir e m es b t th ha e to acco t f the be ty f the m tated pec es.

As Mr Walsh has rem ked to m th

ours of th pare t speci s f th genus f r both se es f f fi e d ly-d trib ted species are coloured in arly th same mann r As in several previ cases, we may here inf r that t th males f 4 th *d m ne* d *genus* which ha departed from th us l t pe f th gen s. In th *Anth* from Cal

som tl r respects. I an allied Indian f rm, th *Iph as gla cippe* th ang t p are fully d loped in both se s. In this Iphias, a

up th d rface resembles th fl h l

pped th bright ang f th sam purpose, especially wh n this charact m confined to th mal s.

Most m ths r t m t nl ss dun g tl hole gre t part f th dav w th tl ings d pressed nd th wh l uppe urface shaded and col red in an admirabl mann as M Wallace has m ked f scap g d tect n. Th fro t gs f th Bombycidæ, hen t rest, g rally lap and conceal tl hind g so that th latt m ght be brightly col ed with t m ch risk and th y are i fact ft thus coloured D ring fl ght, m ths ld often be bl to escape from th e-mies rth less, as th l d ing re th full posed t w th bright col rs must gen ally ha bee acquired t som l ttl risk. B t th f llow g fact h w h w ti s

w ght t be in drawing conclus ons n th s head The comm n y ll w unde wings (Triphæna) ft n fly bout during tl day o early g and are then consp cu us from the col f the r hind w gs. It w ld naturally be tl ought th t this would b source f dan g r b t Mr J Jen e W r bel s tl at t actually serves th m as a m ans f esc pe for

rous pecime f *Triphæna p ba*, which was instantly p rsued by a rob n but th b rd s ttenti b ing ca ght by th col red wings th m tl was t captured unt l aft bo t fifty tt mpts, and mall port s of the w gs w re repe tedly broke ff H tried tl sam xperime t, in th pen r w th swal low and *T fimbria*, b t tl larg siz of this m tl prob bly te f red witl ts capt re[15] W thus emi ded f a tat m nt made by M W llace[16] nam ly that n th B azilian f re ts and Malay sl ds, many comm n and highly-deco ted b tt rfl e are w ak fly rs, th gh furnished w th a l oad e panse f wi g and th y are fte capt ed w th p rced and brok n w gs, as f tl e had been seized by b rd f m wl ch tl ey had escaped if tl wings had bee m ch malle in propor ti t th body t se m probabl that th insect uld mo f eq ntly hav been truck n rced in a v tal part, and thus the in creased expanse f th wings may ha be n indir tly be eficial

Display —The bright col urs f many butt fl es and of som m ths are specially arranged f display so that th y m y be read ily see During th ght col m re n t vi ble and th re can be n d ubt that th noct rnal m ths, tak n as body are m ch l ss gaily decorated than b tt rfl es, ll f whi h are d rnal in th habits B t th m th f certain famili s, h as th Zygænidæ, se al Sphingidæ, U anidæ, some Arctiidæ and S turniidæ, fly bo t during th d y arly ning, and many f th se re xtrem ly b tif l, b ing far bright col ured th n th stri tly octurnal ki ds. A f w cepti nal cases, h w f bright-col ured noct rnal speci ha been reco ded

[14] See the terest g bser tions by T W Wood, the *Student*, Sept., 1868, p. 81

[15] M Wallace *H dwick Science Gossip*, September 186? p. 193

[16] See also, this bject, Mr W ir paper in *T nsact ons Entomological Society* 1869 p. 23

[17] *W stm nster Review* J ly 1867 p 16

[18] F nsta ce Lithosia but Prof Westwood (*M dern Clas f Insects* ol ii., p 390) seem ur

There is evidence of another kind in regard to display Butterflies as before remarked elevate their wings when at rest but whilst basking in the sunshine often alternately raise and depress them thus exposing both surfaces to full view and although the lower surface is often coloured in an obscure manner as a protection yet in many species it is as highly decorated as the upper surface and sometimes in a very different manner In some tropical species the lower surface is even more brilliantly coloured than the upper [18] In the English fritillaries (Argynnis) the lower surface alone is ornamented with shining silver Nevertheless as a general rule the upper surface which is probably more fully exposed is coloured more brightly and diversely than the lower Hence the lower surface generally affords to entomologists the more useful character for detecting the affinities of the various species Fritz Müller informs me that three species of Castnia are found near his house in S Brazil of two of them the hind wings are obscure and are always covered by the front win s when these butterflies are at rest but the third species has black hind wings beautifully spotted with red and white and these are fully expanded and displayed whenever the butterfly rests Other such cases could be added

If we now turn to the enormous group of moths which as I hear from Mr Stainton do not habitually expose the under surface of their wings to full view we find this side very rarely coloured with a brightness greater than or even equal to that of the upper side Some exceptions to the rule either real or apparent must be noticed as the case of Hypopyra [1] Mr Trimen informs me that in Guenee s great work three moths are figured in which the under surface is much the more brilliant For instance in the Australian Gastrophora the upper surface of the fore wing is pale greyish ochreous while the lower surface is magnificently ornamented by an ocellus of cobalt blue placed in the midst of a black mark surrounded by orange yellow and this by bluish white But the habits of these three moths are unknown so that no explanation can be given of their unusual style of colouring Mr Trimen also informs me that the lower surface of the wings in certain other Geometræ[17] and quadrifid Noctuæ are either more variegated or more brightly coloured than the upper surface but some of these species have the habit of holding their wings quite erect over their backs, retaining them in this position for a con ider able time and thus exposing the under surface to view Other species when settled on the ground or herbage now and then suddenly and slightly lift up their wings Hence the lower surface of the wings being brighter than the upper surface in certain moths is not so anomalous as it at first appear The Saturniidæ include some of the most beautiful of all moths, their wings being decorated as in our Briti h emperor moth with fine ocelli and Mr T W Wood[18] observes that they resemble butterflies in some of their movements for instance in

the case with many brilliant butterflies The male however of one American moth the *Saturnia io* is described as having its fore wings deep yellow curiously marked with purplish red spots whilst the wings of the fe

low tints or nearly white In several species the males are much darker than the females [19]

p s d t th s cas On th el ti e colours f d urn l nd n tu nal Lep d pter e *bid* pp 333 d 392 also Ha ris *T atise n th Ins cts of New E g land* 1842 p 315

[15] h d ff en is b tween the upp r nd lo er surfaces f the w gs of se er l pec es f P p l o m y b een in th b tif l plat s to M W ll Mem th P p l dæ f th M l y n Re gion in *Tr nsactions of th L nne Society* l xxv part i 1865

See Mr W rmald on this m th *P oc ed g f the Entomological Society* March 2, 1868

[1] See lso an ccou t f th S Am ican g nus Erate na (n f the G m t æ) *T nsactio E t Soc* n w l pls v nd

P oc Ent Soc of Londo July 6 1868 p

Ha s, *T eatise &c* ed ted by Fl 1862, p

f rm m th t w h r h h bel s n

d M Sta t bse ed th t this l tter m th as r j cted w th utt disgust by a wh le brood f y g turk ys, wh ch re fond f ting ther

and these belong to groups which generally fly about during the afternoon. On the other hand in many genera, as Mr Stainton informs me, the males have the hind wings whiter than those of the female—of which fact *Agrotis exclamationis* offers a good instance. In the ghost-moth (*Hepialus humuli*) the difference is more strongly marked the males being white, and the females yellow with darker markings.[11] It is probable that in these cases the males are thus rendered more conspicuous, and more easily seen by the females whilst flying about in the dusk.

From the several foregoing facts it is impossible to admit that the brilliant colours of butterflies, and of some few moths, have commonly been acquired for the sake of protection. We have seen that their colours and elegant patterns are arranged and exhibited as if for display. Hence I am led to believe that the females prefer or are most excited by the more brilliant males for on any other supposition the males would, as far as we can see, be ornamented to no purpose. We know that ants and certain lamellicorn beetles are capable of feeling an attachment for each other and that ants recognise their fellows after an interval of several months. Hence there is no abstract improbability in the Lepidoptera, which probably stand nearly or quite as high in the scale as these insects, having sufficient mental capacity to admire bright colours. They certainly discover flowers by colour. The humming-bird sphinx may often be seen to swoop down from a distance on a bunch of flowers in the midst of green foliage and I have been assured by two persons abroad, that these moths repeatedly visit flowers painted on the walls of a room, and vainly endeavour to insert their proboscis into them. Fritz Müller informs me that several kinds of butterflies in S. Brazil shew an unmistakable preference for certain colours over others he observed that they very often visited the brilliant red flowers of five or six genera of plants, but never the white or yellow flowering species of the same and other genera, growing in the same garden and I have received other accounts to the same effect. As I hear from Mr Doubleday the common white butterfly often flies down to a bit of paper on

or tu ...

flies in the Malay Archipelago, states that a dead specimen pinned upon a conspicuous twig will often arrest an insect of the same species in its headlong flight, and bring it down within easy reach of the net, especially if it be of the opposite sex.

The courtship of butterflies is, as before remarked, a prolonged affair. The males sometimes fight together in rivalry and many may be seen pursuing or crowding round the same female. Unless, then, the females prefer one male to another the pairing must be left to mere chance, and this does not appear probable.

males, ...

rendered brighter by degrees, and will have been transmitted to both sexes or to one sex according to the law of inheritance which has prevailed. The process of sexual selection will have been much facilitated, if the conclusion can be trusted, arrived at from various kinds of evidence in the supplement to the ninth chapter namely that the males of many Lepidoptera, at least in the imago state, greatly exceed the females in number.

Some facts, however, are opposed to the belief that female butterflies prefer the more beautiful males thus, as I have been assured by several collectors, fresh females may frequently be seen paired with battered, faded, or dingy males but this is a circumstance which could hardly fail often to follow from the males emerging from their cocoons earlier than the females. With moths of the family of the Bombycidae, the sexes pair immediately after assuming the imago state for they can not feed, owing to the rudimentary condition of their mouths. The females, as several entomologists have remarked to me, lie in an almost torpid state and appear not to evince the least choice in regard to their partners. This is the case with the common silk moth (*B mori*) as I have been told by some continental and English breeders. Dr Wallace who has had

moths, so that if the Cyenia was commonly mistaken by British birds for the *plebeiana*, it would escape being devoured, and its hue deceptive colour would thus be highly beneficial.

It is remarkable, that in the Shetland Islands the male of this moth, instead of differing widely from the female, frequently resembles her closely in colour (see Mr MacLachlan, *Transactions Entomological Society*, vol iv, 1866, p. 459). Mr G Fraser suggests (*Nature*, April, 1871 p. 489) that at the season of the year when the ghost moth appears in these northern islands, the whiteness of the males would not be needed to render them visible to the females in the twilight night.

Rambles of a Naturalist in the Chinese Seas, 1868, p. 152.

great experience in breeding *Bombyx cynthia* is convinced that the females evince no choice or preference He has kept above 300 of these moths together and has often found the most vigorous females mated with stunted males The reverse appears to occur seldom for as he believes the more vigorous males pass over the weakly females and are attracted by those endowed with most vitality Nevertheless the Bombycidæ though obscurely coloured are often beautiful to our eyes from their elegant and mottled shades

I have as yet only referred to the species in which the males are brighter coloured than the females and I have attributed their beauty to the females for many generations having chosen and paired with the more attractive males But converse cases occur though rarely in which the females are more brilliant than the males and here as I believe the males have selected the more beautiful females and have thus slowly added to their beauty We do not know why in various classes of e males of e

as seems to be the general rule in the animal kingdom but if contrary to what generally occurs with the Lepidoptera the females were much more numerous than the males the latter would be likely to pick out the more beautiful females Mr Butler shewed me several species of Callidryas in the British Museum in some of which the females equalled and in others greatly surpassed the males in beauty for the females alone have the borders of their wings suffused with crimson and orange and spotted with black The plainer males of these species closely resemble each other shewing that here the females have been modified whereas in those cases where the males are the more ornate it is these which have been modified the females remaining closely alike

In England we have some analogous cases though not so marked The females alone of two species of *Thecla* have a bright purple or orange patch on their fore-wings In Hipparchia the sexes do not differ much but it is the female of *H janira* which has a conspicuous light brown patch on her wings and the females of some of the other species are brighter coloured than their males Again the females of *Colias edusa* and *hyale* have orange or yellow spots on the black marginal border represented in the males only by thin streaks and in Pieris it is the females which are ornamented with black spots on the fore-wings, and these are only partially present in the males Now the males of many butterflies are known to support the females during their marriage flight but in the species just named it is the females which support the males so that the play is re throughout commonly take the active share in wooing and their beauty seems to have been increased by the females having accepted the more attractive individuals but with these butterflies, the females take the more active part in the final marriage ceremony so that we may suppose that they likewise do so in the wooing and in this case we can understand how it is that they have been rendered the more beautiful Mr Meldola from whom the foregoing statements have been taken says in conclusion "Though I am not convinced of the action of sexual selection in producing the colours of insects it cannot be denied that these facts are strikingly corroborative of Mr Darwin's views"

As sexual selection primarily depends on variability a few words must be added on this subject In respect to colour there is no difficulty for any number of highly variable Lepidoptera could be named One good instance will suffice Mr Bates shewed me a whole series of specimens of *Papilio sesostris* and *P childrenæ* in the latter the males varied much in the extent of the beautifully enamelled green patch on the fore wings and in the size of the white mark and of the splendid crimson stripe on the hind wing

ess beautiful than of *P childrenæ* and it likewise varies a little in the size of the green patch on the fore wing and in the occasional appearance of the small crimson stripe on the hind wings borrowed as it would seem from its own female for the females of this and of n

of *childrenæ* there was but a small interval and it was evident that as far as mere variability is concerned there would

Ap 1 77 Meldola 77 the

be no difficulty in perman tly increasin th bea ty of eith speci by means f selection. The ariabilit is here almost confined to the male se b t Mr Wallace and M B tes ha shewn that the f males f som pecies are extrem ly ariabl th mal s being nearly constant. In f ture ch pt r I shall ha oc casio to sh w that th be tiful lik spots, ocelli, f und n th wings f many Lepid pt ra, are min tly ariabl I may here add that these ocelli r a difficulty n the theory f se ual selecti f th gh p pearin t us so rnam ntal, th are n prese t in sex and abse t in th th r n do th y diff much in th tw se es. This fact t present inexplicab b t if t should h reaft be f und that th f rmati of an ocellus is d to some chang in th l

m comm nly passin ...

latt r haunting gloom f re ts. It is th ref re possibl that diff rent conditi ns of lif may ha acted directly on the tw se s but this is n t probable as in th adult stat th are exposed to diff rent conditions d rin a ry sh rt period and th larvæ of both are ex posed t th same co diti ns. M Wallace beli es that th diff rence between th sexes is d t so m ch t th males h g been modified as t th f mal having in all r al most all cases acquired dull col urs f th sak f protecti n. It seems to me on th con trary far m re probabl th t t is the males which ha been chi fl modified through sexual selecti n, th f males having been com parati ly littl chan ed. W can thus und tand how t is that th females f allied spe cies rally resembl n an th so much

alone.

On th wh le, altho gh many seri us objec tions may be urged, it seems probabl that most of th brilliantl col ured species f Lepid pt ra w th ir col urs t sexual selec tion, excepting in certain cases, prese tly t be m tio d in which consp cu us colours ha been gained thro h mimicry as protecti From the ard f th mal thro gho t th animal kingd m, h is g n rall willing to ac cept any f mal and t is th f mal which usually rts cho ce ce if sexual selec tio has been ffici nt w th th Lep d pt ra, th mal wh th se es diff ght t be the more brilliantl coloured and this un doubtedl is th case When both sexes are brilliantl coloured and resembl ach th the charact rs acquired b th males ppear t ha bee transmitted to both. W are led to this conclusio b cases, w thin th sam genus, of gradati from an extraordinary amount of diff rence t id tity in colo be t ee th se es.

B t t ma be a ked wh th th diff rence colour bet een th se es may n t be ac

th y bel ng. Th y ha e, how er almo t alw y been som what modified by the trans f t th m f som f th successi e aria ns, through th accumulation of which th males w re rend red be tif l. B t I do n t wish to d ny that the f males alon f som species ma ha been pecially modified f protection. In m t cases the males and f males of distinct species will ha been xposed during th ir prol nged larv l tate to diff rent conditi ns, and ma ha been th affected though with th males any sli t chang of colour thus caused will gen rally ha been masked by th brill ant tints gained thro gh sexual selection. Wh n w tre t of birds, I shall ha t discuss th wh l q esti n, as to h w far th diff rences in col ur between th sexes are d to th males having been modi fied thro gh sexual selecti n f ornam ntal purposes, to th f males havi been modi fied thro gh natural selecti n f the sak f protection, so that I will h re say b t littl n th subject.

In all th cases in which th more common f rm of equal inh ritance by both sexes has

Wallace the P pilio idæ of the Malayan Region, T ansact L nn. oc ol. 1865, pp. 8, 36 A trik g case of rare variety trictly in ermediate bet ee t other w ll-marked f male arieties, gi by Mr Wallace. See also M B es, P oc Entomolog Soc N 19 1866, p. xl. M Bates as so kind as t lay th bject be fore the Entomological Society and I have received answers to this ffect from several ntomologists.

H. W B tes, Th Naturalist the Amazons, vol. ii., 1863, p. 228. A. R. Wallace, in T ansact ns Li nea Society l xxv 1865 p 10

On this hole ubject see *The Variatio of A imals and Plants nder Domestication*, 1868, ol. ii., chap. xxiii.

great experience in breeding *Bombyx cynthia* is convinced that the females evince no choice or preference He has kept above 300 of these moths together and has often found the most

weakly females and are attracted by those endowed with most vitality Nevertheless the Bombycidæ though obscurely coloured are often beautiful to our eyes from their elegant and mottled shades

I have as yet only referred to the species in which the males are brighter coloured than the females and I have attributed their beauty to the females for many generations having chosen and paired with the more attractive males But converse cases occur though rarely in which the females are more brilliant than the males and here as I believe the males have selected the more beautiful females and have thus slowly added to their beauty We do not know why in various classes of animals the males of some few species have selected the more beautiful females instead of having gladly accepted any female as seems to be the general rule in the animal kingdom but if contrary to what generally occurs with the Lepidoptera the females were much more numerous than the males the latter would be likely to pick out the more beautiful females Mr Butler shewed me several species of Callidryas in the British Museum in some of which the females equalled and in others greatly surpassed the males in beauty for the females alone have the borders of their wings suffused with crimson and orange and spotted with black The plainer males of these species closely resemble each other shewing that here the females have been modified whereas in those cases where the males are the more ornate it is these which have been modified the females remaining closely alike

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that the part which the two sexes play is reversed as is their relative beauty Throughout the animal kingdom the males commonly take the more active share in wooing and their beauty seems to have been increased by the females having accepted the more attractive individuals but with these butterflies, the females take the more active part in the final marriage ceremony so that we may suppose that they likewise do so in the wooing and in this case we can understand how it is that they have been rendered the more beautiful Mr Meldola from whom the foregoing statements have been taken says in conclusion "Though I am not convinced of the action of sexual selection in producing the colours of insects, it cannot be denied that these facts are strikingly corroborative of Mr Darwin s views"

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son stripe on the hind wings borrowed as would seem from its own female for the females of this and of many other species in the Æneas group possess this crimson stripe Hence between the brightest specimens of *P sesostris* and the dullest of *P childrenæ* there was but a small interval and it was evident that as far as mere variability is concerned there would

1 97 1871 p 08 Mr Meldola

amply confirmed [a] especially by M Belt Hence M B t s inf rred that th butt rfl es which m tate th protected pec ha e ac quired th ir prese t marv ll u ly decepti e ppeara ce thro gh ariati n and n tural sel tion, in ord to b m tak n f th protected kinds, and th s t scape b g d ured N explanat n s h re tt mpted f the brilliant col rs of th m tated but nly f h m t t g b tt rfl es. W m t acco nt f

B tes pape imilar and eq ally t iking facts h e bee bserved by Mr W llace in th Malayan reg by Mr T ime in South Africa, and by Mr Ril y in the U ted Stat s.[a]

As som wr ters ha f lt much diffi ulty in d rstanding h w th first t ps n the proc ess f mimicry could ha been ffected thro gh tural selecti t may be w ll t remark that th p oc ss probably comm ced lo g ag between f rm n t w d ly d ss milar in colour I this case n a sl ght ariat n w ld be be fi ial if t dered th pe ci m re lik th th and afterward th m tated peci might b modified t an x trem d gree thro gh se ual select r oth m ans, and if th chang w re gradual th mitat rs m ght asily be led al g th same track u til th y diff red to an q ally trem d gree from th ir rig nal nd t and th y w ld th ltim t ly assum an

many peci f Lep d ptera are liabl t con sid abl and abrupt ar ti n in col u A few instances ha bee g n in thi ch pte and many m re m y b f nd i th papers f M B te and M Wallace

W th se al peci th sex are alik and imitate th tw se es f an th peci s. B t M Trim g s, in th p pe alr ady re f rred to thre ases which th se f th imit ted f rm d ff f m ach th col ur and th se es f th mitating f rm d ff m l k man Se al cases ha also been recorded where the f males al ne imitate bril liantly-col ured a d p otected pecies the male retaining the normal aspect f their immed te co ge e s. It is here bv us th t the s cce v ariation by which the f m le has been mod fed h e been tran m tted to h r al n It is, how v r p ob bl th t some ... e ariat ons would ha ...

served wl ch w re from th f t str y limited in th transmiss n to th f male sex W h v a partial illu tr ti n of these remarks in a tat m nt by Mr B lt [a] that the males f some f th *Leptalid s, which imitate* protected spec es, till retain in a concealed man ne some f th r origin l characters. Th us n th *males* the pper half f the l w r wing is f pure wh t whilst all th re t f th e wings is barred and potted w th black, red and y l l w lik the pec es th y m mic. Th fem les ha n t this white p tch, and th male usu ally co ceal t by coveri g t w th th upper wing so that I cann t im gi e ts being f any th use to th m than as an ttract n n co rtship wh they xh bit t t th females,

Bright Colo f Cat rpilla —Whilst reflecting on the be uty f many b tterfl es t occurred to m th t som caterp llars w re pl didly col red and as sexual lect n could n t pos bly ha b re acted t ppeared rash to ttrib t th b auty f th mature sect t thi ag y unl ss the bright col u s f th ir larvæ could b someh w explain d In the first place t may be bserved th t the col urs f caterp llars d n t stand an cl se correl t n w th th se f th mat re nsect Seco dly th bright col ur d *not serv* n any rd nary mann as protect M B te nf rm m as an instance f this, th t th m t con p cat rp llar wh h h beh ld (that f phinx) l ed th l ge gree l f a tree n th pen llan f South Am rica t was ab t f i che in l gth t an sely banded w th black and y ll w and with ts head l gs, and tail f a bright red H nce t ght th y of any o e wh passed by n t th di tance f many yards, and n d bt th t of e ry pas g bird

B tes theory ...

[a] *The Nat alist Nic agua*, 1874 p. 385

prevailed the election of bright-coloured males would tend *to make the females bright* coloured and the selection of dull-coloured females would tend to make the males dull If both processes were carried on simultaneously they would tend to counteract each other and *the final result would depend on whether a* greater number of females from being well protected by obscure colours or a greater *number of males by being brightly-coloured* and thus finding partners succeeded in leaving more numerous offspring

In order to account for the frequent transmission of characters to one sex alone Mr Wallace expresses his belief that the more common form of equal inheritance by both sexes can be changed through natural selection into inheritance by one sex alone but in favour of this view *I can discover no evidence* We know from what occurs under domestication that new characters often appear which from the first are transmitted to one sex alone and by the selection of such variations there *would not be the slightest difficulty in giving* bright colours to the males alone and at the same time or subsequently dull colours to the females alone In this manner the females of some butterflies and moths have it is prob*able been rendered incon picuous for the sake* of protection and widely different from their males

I am however unwilling without distinct evidence to admit that two complex processes *of selection each requiring the transference of* new characters to one sex alone have been carried on with a multitude of species —that the males have been rendered more brilliant by beating their rivals and the females more *dull coloured by having escaped from their* enemies The male for instance of the common brimstone butterfly (Gonepteryx) is of a far more intense yellow than the female though she is equally con picuous and it does not *seem probable that she specially acquired* her pale tints as a protection though it is probable that the male acquired his bright colours as a sexual attraction The female of *Anthocharis cardamines* does not possess the beautiful orange wing tips of the male consequently she closely resembles the white butterflies (Pieri) so common in our gardens but we have no evidence that this resemblance is beneficial to her As, on the other hand she resembles both sexes of several other pecies of the genus inhabiting various quarters of the world it is probable that she has simply retained to a large extent her primordial colours.

Finally as we have seen various considerations lead to the conclusion that with the greater number of brilliantly-coloured Lepidoptera it is the male which has been chiefly modified through sexual selection the amount of difference between the sexes mostly depending on the form of inheritance which has prevailed Inheritance is governed by so many unknown laws or conditions that it seems to

ess of variation are necessarily transmitted

at all between the sexes of allied pecies These cases of gradation it may be added are much too common to favour the suppo ition that we *here see females actually undergoing* the process of transition and losing their brightness for the sake of protection for we have every reason to conclude that at any one time the greater number of pecies are in a fixed condition

Mimicry —This principle was first made clear in an admirable paper by Mr Bates,[a] who thus threw a flood of light on many obscure problems It had previously been observed that certain butterflies in S America belonging to quite dist nct families, re embled

As the Heliconidæ are coloured in their usual manner whilst the others depart from the

cies are comparatively ra e whilst the imitated abound and that the two sets live

concluded that they must be protected from the attacks of *enemies* by some secretion or odour and this conclus on has now been

Th ... *Animal* ... *nd Plants* ... *der Domestication*, ... ch ... p. 17
Transact. Linn. Soc. ... 1862, p 495

adm ts th ag ncy f selecti n of any kind ll after ading th bo e disc ss on, d s- p t th t th se m s al in trum nt h been acq ired thro gl sexu l selection. In f ur th Orde th m mb rs f n se m re f ll se s are p ded th

al se et
d rful d ty f the mea f pro- d ci g so d possessed b the mal al n

From th reasons ass gned in th last cl p- t t p b bl that th gre t l m po sessed by th m les f many lam ll corn and som th beetles ha e been acquired as rna- m ts. From th mall ize f insects, w re apt to nd rval th ppe ance If w co ld magine m l Chalcosoma (fig 16) w th ts polished bro zed coat f mail d ts

Tl col ring f insects is compl and obscure bject Wh th m l d ff l ghtly from th f m l and n th are brill tly col ured t is probabl that th se es h aried in l ghtly diff re t mann and th t th ri ti ns ha bee t an mitted b ach se t th sam w th t any b fit l thus accruing Wl th mal b ll tly col red and d ff co p cu ly from th f mal as th som d g nfl and many b tt fl es, t prob bl th t h lu col rs to se al select whilst th f mal has retai ed prim rd al ry anci t typ f col rin l ghtl modified by ll g es bef re xpla ed B t in som ase th f m l has ppare tl bee mad bscure by tio t ansm tted t h al as m f d rect protect and t is alm t ce tai th t tl ha som tim bee mad brilliant, so as to m tate th protected pec es inl ab ting th sam distri t. Wh th se resembl ach th and both are bsc ly col red th re is d bt that th y h bee a m ltit d l case so coloured f th sak f

protect n So f s in some n tance wh n both a e b ltly-col ured f they thu m t t protected species, or resemble su round g object u h as fl we s r th y gi e ot ce t th r n m e that they are unpal tabl In oth r cases in wh h th se s esembl each th and are b th b ll ant, especially wl n the col rs re a ra ged fo d pl y we may co clud th t tl y ha e been gained b the mal se as n att act n and h be n trans- fer ed t the femal We ar more pec lly led t th conclu when r the same type

whilst others diff l ghtly o n t at all w th inte med te g adat n co nectin these e tr me tat s.

I tl sam mann as bri ht col urs l a ft n been part ally t nsf rred from th mal to th f males, so t has been with the xt r

and Orth pte ha g n rally been t ans- f rred in a rud m ntary e n in a n ly p rfect co dit to the f mal yet n t f fi i ntl pe fect to b f any use It is lso an int t g fact, as b ring n se al sel ti n th t th st d lating o gans of certain m l Orth pt re n t f lly de l ped unt l th last m lt and that th colo f ce tain mal d g fli re t f lly d loped u til som l ttl time aft tl r em gence from the p pal tat and wl th y are ready to b eed

Sexu l select mplies th t the m re t tracti d d l re p f rred by th p- posit se and as with sects wh n the d ff t is th mal which, with som are except ns, th m re rnamented and d parts m re from th typ to which th peci b l g —and as i s th mal whicl se rel eag ly f th f m l w m t ppose tl t tl f mal h b t ally occas nally pref r th m re bea tif l m le nd that th se h e thus acq red tl b ty Th t th f m l in m t all th Ord rs w ld h the pow f rejecting any p t ul mal is prob bl from tl many ingular contr posse sed by th mal s, ch as gre t j ws, dh h ns, p s, l g ted l gs, & f r seiz ing th f mal f th se co tri hew th t tl re som d ffi lty th act, so that h co rre ce ld seem necessary J dg g from wl t w kn w f th percept po rs and ffecti ns f ari us insects th re

I then applied to Mr Wallace who has an innate genius for solving difficulties After some consideration he replied Most caterpillars require protection as may be inferred from some kinds being furnished with spines or irritating hairs and from many being coloured green like the leaves on which they feed or being curiously like the twigs of the trees on which they live Another instance of protection furnished me by Mr J Mansel Weale may be added namely that there is a caterpillar of a moth which lives on the mimosas in South Africa and fabricates for itself a case quite indistinguishable from the surrounding thorns From such considerations Mr Wallace thought it probable that conspicuously coloured caterpillars were protected by having a nauseous taste but ...

mely

rude

... as fatal to them as if they had been devoured Hence as Mr Wallace remarks distastefulness alone would be insufficient to protect a caterpillar unless some outward sign indicated to its would be destroyer that its prey was a disgusting morsel Under these circumstances it would be highly advantageous to a caterpillar to be instantaneously and certainly recognised as unpalatable by all birds and other animals Thus the most gaudy colours would be serviceable and might have been gained by variation and the survival of the most easily recognised individuals

This hypothesis appears at first sight very bold but when it was brought before the Entomological Society[33] it was supported by various statements and Mr J Jenner Weir who keeps a large number of birds in an aviary informs me that he has made many trials and finds no exception to the rule that all caterpillars of nocturnal and retiring habits with smooth skins all of ...

all

...

... es When the birds rejected a caterpillar they plainly shewed by shaking their heads and cleansing their beaks that they were disgusted by the taste[34] Three conspicuous moths were ... by Mr ... and were rejected though other kinds were eagerly eaten Thus the probability of Mr Wallace's view is confirmed namely that certain caterpillars have been made conspicuous for their own good so as to be easily recognised by their enemies, on nearly the same principle that poisons are sold in coloured bottles by druggists for the good of man We cannot however at present thus explain the elegant diversity in the colours of many caterpillars but any species which had at some former period acquired a dull mottled or striped appearance either in imitation of surrounding objects or from the direct action of climate &c almost certainly would not become uniform in colour when its tints were rendered intense and bright for in order to make a caterpillar merely conspicuous there would be no selection in any definite direction.

Summary and Concluding Remarks on Insects.—Looking back to the several Orders we see that the sexes often differ in various characters the meaning of which is not in the least understood The sexes also often differ in their organs of sense and means of locomotion so that the males may quickly discover and reach the females They differ still oftener in the males possessing diversified contrivances for retaining the females when found We are however here concerned only in a secondary degree with sexual differences of these kinds.

In almost all the Orders the males of some species even of weak and delicate kinds are known to be highly pugnacious and some fe... are furnished with special weapons for fighting with their rivals But the law of battle does not prevail nearly so widely with insects as with the higher animals Hence it probably arises that it is in only a few cases that the males have been rendered larger and stronger than the females On the contrary they are usually smaller so that they may be developed within a shorter time to be ready in large numbers for the emergence of the females.

In two families of the Homoptera and in three of the Orthoptera the males alone possess sound producing organs in an efficient state These are used incessantly during the breeding season not only for calling the females but apparently for charming or exciting them in rivalry with other males No one who

[33] *Proceedings Entomological Society* Dec 3 1866 p xlv ... d March 4 186 p lx x

[34] See Mr J Jenner Weir's paper on Insects and Insectivorous Birds in *Transact Ent. Soc* 1869 p ... also Mr Butler's paper *ibid* p 27 Mr Riley has given analogous facts in the *Third Annual Report on the Noxious Insects of Missouri* 1871 p 148 Some opposed cases are h... by Dr W... l... ce and M H d'Orville see *Zoological Record* 1869 p 319

CHAPTER XII

SECONDARY SEXUAL CHARACTERS OF FISHES AMPHIBIANS AND REPTILES

We h now arri ed at th gre t sub-king d m of th V t b ta, and w ll comm nce th the lowest class, th t f fi.hes The males of plagio t m s fish s (harks, y) and f ch macro d fishes are pro ded with laspers which serv to tain th f mal l ke the an us structures possessed by ma y f th lowe animals. Besid th laspe s, th males f many ays h clusters f tro g sharp spines n th ir h ads, and se ral row alo g the pper t urf ce f th pec toral fins. Th se are present in th mal f some pecies, wh ch ha th p rts f th bodies smooth They are l) t mporarily d loped during th breeding season and D Gu the uspects that th y ar bro ght to actio as prehensil rgans by th d bling inward and d nw rd f th tw des of th body It is remarkable fact th t th females and t the mal f som pec as f Raia la at ha th backs t dded with larg hook f rmed p s.

th f mal wl lst sh runs w th great swift ess th sandy beach, d tl re d po ts h sp n Th wid ly dist ct M nac thus copas prese ts som wh t an log stru ture Tl mal as D G th inf rms me has l t f tuff traight p s, lik those of comb th d f th tail and th se in specim in hes l g w re nearly and half in hes in l gth th f mal has in th sam place l t f bristl s, which m y be compared th th se f tooth brush. I an tl spec M peron th mal has bru h lik that possessed by th f mal f th last pec h lst tl d f th tail in tl fe mal are mooth I som th pecies f th sam genus th tail can be perce ed to b a l ttl ro gh ed in th mal and perfectly mooth th f m l and lastly in th rs, both se es ha mooth sides

Th male of many fi h fight f r the po ses si n f the f mal s. Th s the mal st ckleback (Gasterosteu le rus) has been d scribed as mad with d l ght wl n the fem l come out of h r hiding place nd survey the n t wh ch h has made f h He darts r nd l in ev ry d rect o then to l s accum lated t ri l f the nest, then back gain ı an

Th battles re at t mes de pe te r these puny comb tants fast n t ght h other f r se al seco ds, tumbli g e nd gain until th ir t th ppe rs com plet ly exh ted W th th rougl tailed ti kl back (G t ack rus) th mal s whilst fighting w m ro d and round each tl h ti g and de our g to p rce each otl with th aised l t ral pines. Th sam writ adds, tl b t f th se little f ries ery se re Th y also use th ir late al p n with s ch f tal ffect, th t I h re n during a b ttl bsol tely rip h ppo e t quite pen so th t h sank to th b ttom and d ed Wh n a fish is conqu red his g llant be ring f rsak s h m h s g y l urs fad w y and h hid l disgrace am g his peaceabl compan s, but f som t m th constant bject f his co q ro persec t n

Th m l salm as p gnaci s as th littl t kl back and so th m le tro t as I l from D Gu th Mr Shaw saw a o- l nt co t t b tween tw m l lm n wl ch lasted th wh l d y and M R B ist, S p- rintend t f F h ries, informs m th t h has ft n w tched from th bridg t l rth th mal dr ing y th n als, whilst th f m les w re spawni g Th males re con tantly figl ting and t aring each the the sp wning beds, and many so inj re each th r

Yarrell Hist f Brit h F he ol 1836 pp 417 425 436 D G ther f m that th pines R clavata are pec l t th female

The Americ Nat al st, Ap l, l 71 p 119

18 0 p 331

is no antecedent improbability in sexual selection having come largely into play but we have as yet no direct evidence on this head and some facts are opposed to the belief Nevertheless when we see many males pursuing the same female we can hardly believe that the pairing is left to blind chance—that the female exerts no choice and is not influenced by the gorgeous colours or other ornaments with which the male is decorated

If we admit that the females of the Homoptera and Orthoptera appreciate the musical tones of their male partners and that the various instruments have been perfected through sexual selection there is little improbability in the females of other insects appreciating beauty in form or colour and consequently in such characters having been thus gained by the males But from the circumstance of colour being so variable and from its having been so often modified for the sake of protection it is difficult to decide in how large a proportion of cases sexual selection has played a part This is more especially difficult in those Orders such as Orthoptera Hymenoptera and Coleoptera in which the two sexes rarely differ much in colour for we are then left to mere analogy With the Coleoptera however as before [illegible] n [illegible] e [illegible] a [illegible] ucs see a mutual attachment between the sexes that we find the males of some species possessing weapons for sexual strife others furnished with wonderful horns, many with stridulating organs and others ornamented with splendid metallic tints Hence it seems probable that all these characters have been gained through the same means, namely sexual selection With [illegible] e the pains [illegible] can [illegible] that they would act thus unless the display was of use to them in their courtship

When we treat of birds, we shall see that they present in their secondary sexual characters the closest analogy with insects Thus, many male birds are highly pugnacious, and some are furnished with special weapons for fighting with their r[illegible] organs [illegible] son for [illegible] They [illegible] quently ornamented with combs horns, wattles and plumes of the most diversified kinds and are decorated with beautiful colours all evidently for the sake of display We shall find that as with insects both sexes in certain groups are equally beautiful and are equally provided with ornaments which are usually confined to the male sex In other groups both sexes are equally plain-coloured and unornamented [illegible] in some few anomalous cases the females are more beautiful than the males We shall often find in the same group of birds every gradation from no difference between the sexes to an extreme difference We shall see that female birds like female insects often possess more or less plain traces or rudiments of characters which properly belong to the males and are of use only to them The analogy indeed in all these respects between birds and insects is curiously close Whatever explanation applies to the one class probably applies to the other and this explanation as we shall hereafter attempt to shew in further detail is sexual selection

lo g t s, and t l g us projection t rns p ard f m tl po t, whi h, wl e tl j ws a l sed occ p s d p ty bet ee tl intermaxillary bo f th ppe j (fig and 8) In l thus hange f tructure last ly d th breeding seaso b t n th *Salm l j* do of

th rı In th se ld mal the j w becomes d l ped to an imm se hook lik projec t n, and tl t th g o t rul fan s, olt m re th half an inch l gth W th tl Europe n salm ccord g t M Ll y d tl t mpo ry hook l k tru tur serv to tre gth and protect th j ws, h n o m l ch g an th th d f l l ce b t t gre tly d l ped teeth f the m l Am n salm m y b comp ed w th tl tusks f many m l m mmals, and th y d t an ff th l an protectiv p rpose

( ) th ad lt mal has sh rp pointed t th d ected back ds, wl l t th f th f m l ar b oad and fl t, and f rm pa m t so th t th se t th d ff th tw es f tl sam peci m tha l di tın t g f th sam f mily Th teeth f tl mal becom h rp ly wl h ad lt hilst g th broad d fl t lik ll se f th f mal A so f q tl occ rs th seco dar se l h t rs, b th se f som pec l s (I in tan *R bat*) h n ad lt, possess l p po ted t th d b cl aract p pe t d prim rily gained by th m l pp t h l ce t m tted t th ff pri g f b th se Th teetl are lik ise po ted both se f *R maculata*, h t nly hen j t adult tl mal acq ring th m t an l g than ll f mal s. W hall h aft meet th analo g case ce tai b ds, which th mal acq re th pl m g comm to both se when ad lt, t som h t l g than d se th f m l W th th pec f th mal cr wl ld n possess sharp te th d onseq tly th ad lts f

b th se es are p vided with b oad ll t teeth lk tl e f tl y u g and like th se of tl e m tur f m les f th above ment d pe ci ls tl e ray are b ld tro g and ac s fi h m y u pect th t tl males require th l rp teeth f fi ht n with th r rivals b t as they po many p ts modi fied d dapted f the p l on of tl e f m l l s poss bl th t th teeth may b used f th p p se

I re ard l M Carbonnie mai ta tl t tl fem l of alm t ll f sl e

pr nod nts th m l is n t e en n half as l g l n many k d f fi h th mal l b t ally figl t t tl e t is rp g th t tl y h n t g ally become la g id t ng than th f m l s through th ff t f se l sel t The mal ff f m tl sm ll f accord t M Carbon tl e liable t b d u ed by th fem l s f th own speci wh n carniv o a d n l bt by tl er pec s Incr ased iz m t l s som mann f more mportance to the f m l s tl an str gth and si ar t th m l s f fight g w th th m l and thus pe haps t ll w f th prod t f a vast numb r f

In man peci th mal lon is orna m ted w tl b ght col o tl m l li ght th mal than th f m le Th mal lso s som t m pro ded w th ppend l h ppea t b f n m use to h m f tl d ary purposes f life than are th t l f th rs t tl p cock I m nd bted f m st f th f ll wing f ts to th kind ess f Dr Gü th Th re reason to s pect tl t m y trop cal fi h d ff ally n col u and tru tu and th re som triki g ase with B t l fi l Th m le *C l ymus ly* has b n called th *g mm d g t* from ts brill ant g m lik col u Wh f h a ght f m tl sea th body y ll f n had s, t ped and potted w th d bl e n tl e l d th d rsal fi pal b tl l k l g t dinal band tl tral ca d l a d an l fi b g bl h ll k Th f mal rd d dra n t w co d red by Linnæus, d b many b q t n tur h ts, as d t ct p c t s f

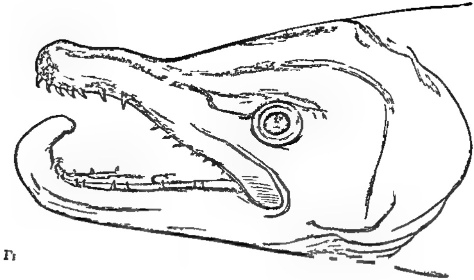
Yarrell, *H to y f British F he* l ii. 1836 p. l

The Nat alist l ac er l l nd l i., 1866 p. 54

Scand navi a Ad ent ol. 1854 pp. 100 104.

See Y rr ll cco t of th y his *Hist ry f British Fishe* l. 1836 p 416 th ll t figure d pp 42 432.

As q ted th *F mer* 1868, p. 369



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Dr Gunth r] a Museum,

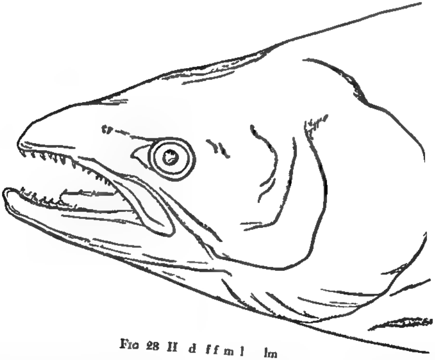


Fig 28 H d f f m l lm

as to cause the death of numbers many being seen swimming near the banks of the river in a state of exhaustion and apparently in a dying state [6] Mr Buist informs me that in June 1868 the keeper of the Stormontfield breeding ponds visited the northern Tyne and found about 300 d ad salmon all of which with one exception were males and he was convinced that they had lost their lives by fighting

The most curious point about the male salmon is that during the breeding season besides a slight change in colour the lower jaw

The F eld, J ne 29 1867 Fo Mr Shaw stat ments ee Ed nbu gh Review 1843 th pe enced bserv (S rop D y f Salm F h g p 60) r marks th t l ke th tag th e m l w uld f he could keep all oth r m l s w y

lo g tes, and cartil gin project n turns p ard f m th point, hich l n the j re closed occ p a deep c ity bet ee th t rm llary bon s f th uppe j " (fig and 8) In o salm thi hange f t t re last nl dur g th l

th m rs. In these ld mal th j becom s d l ped to an mm nse hook lik projec tion, and tl teeth gro nt r gular fang oft m re th lalf an inch n l gtl W th th European alm according t M Ll jd the t mpo ary hook lik tr t se es t tre gth and protect th j wh n o mal charg an th r w tl w d f l l nce b t th gre tly d l ped teeth f th m l Am can salm m be compared w th tl t ks f many male m mmals and they in dic t an ff th l an protect p rpose

Th salm t th ly fi h m wl ch tl teeth diff in th t se as th th case th man j I t th back (R la t) tl ad lt mal has harp pointed teetl direct l backwards, whilst th se f th f m l are b oad and flat, and f rm p ment so that these t th diff m th tw se f tl sam speci m re th ual d t t gen ra f th *sam famil* Th t th f tl mal becom harp nl l n h ad lt hil t ung th ar broad and fl t l k tl se of the f mal A so f eq tl occ w th seco dary se l h act b tl se f som pec f j (f nstance *R bat*) h ad lt, possess harp pointed teetl and here l aract p pe t and prim nly

maculata, b t nly wl en q t ad lt ll male acq ring th m t an l g than th f mal s. W sl all h afte meet w tl analogous case ertai b rds, m wh cl ll mal acq ir th pl m g comm n t b th sexe h ad lt I som h t l g than doe th f m l W th th pec f tl m le wh ld possess sharp t tl and onseq tl th ad lts f

b th e s are pro ded witl broad flat teeth hke tl ose f th ung and like tho of the m tu f l of the abo m nti ed pe As tl e r y re bold tro g and r

fied and dapted f r tl preh on f tl e f m l t po bl tl t th teetl m y b u ed f tl pu pos

I regard t s M C b un r ma tain tl t tl fem le of alm t all f l r l g tua th al and Dr Guntl r loe n t kn w f gle tance h h tl l act ally larg tl ai tl e f mal W tl some primodonts th m l not n half as l rg A man k d f fi l tl n ale l b t ally fight tog tl r t urp g tl t th y h n t g ally become l g r a d tr ng tl an tl f m les th gl th ff t f se l sel ct Th m le ff from tl ir all f ccord g to M Carb n r tl y re l bl t b d red by tl e fem l f tl w pec s wh carnu and l bt by th pec Incr ased iz must l m some man f more mportance t the f mal s, tl n tre gth and t tl m l f figlt g w th ther m l and this p l j t ll w f tl prod ct f vast numb f

In many pec th mal al e is m m ted w th b ght col tl se are m cl bngl t m th m l th the f male The male

f th rs t th pe cock I m d bt d f m t f tl f ll g f ts t th ki d f Dr Guntl Th re t r aso to s pect tl t man trop l fi l d ff se ually n col and tru t re and th re are some t k g case w th ll t h fisl Th male *C l l jm lj* has been lled th *g m e*

pal brown w tl d k l git dinal band tl t al dal d l fi b g bl l black Tl f mal so d d drag n t was co d ed b Linnæ s, and by many ub q t tur l ts, as a d t t pec s t f

Yarrell, *History f British F he* l 1836 p. 1

The Nat alist f *aco er Island*, l 1866 p. 54.

Scand navia *ld entures* ol. i., 1854 pp. 100 104.

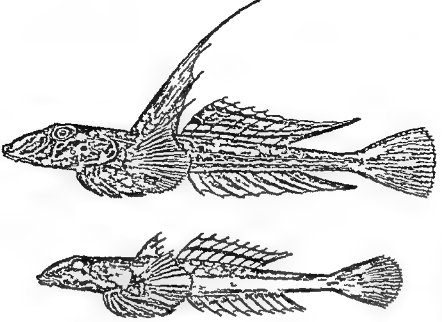


FIG 29 *Call o ymu ly* Upper figur mal l w figur fem l
N B Th lo er figure is mor reduc d th i the upp r

a dingy reddish brown with the dorsal fin brown and the other fins white The sexes differ also in the proportional size of the head and mouth n [1] the eyes [2] the extra ... 29) of the ... Mr W Saville Kent remarks that this singular appendage appears from my observations of the pecies in confinement to be subservient to the same end as the wattles cre ts and other abnormal adjuncts of the male in gallinaceous birds for the purpose of fascinating their mates [13] The young males resemble the adult females in structure and colour Throughout the genus Callionymus [4] the male is generally much more brightly spotted than the female and in several species not only the dorsal but the anal fin is much elongated in the males

The male of the *Cottus scorpius* or sea serpent, is slenderer and smaller than the female There is also a great difference in colour between them It is difficult as Mr Lloyd[5] remarks for any one who has not seen this fish during the spawning season when its hues are brightest to conceive the admixture of brilliant colours with which it, in other respects so ill favoured is at that time adorned Both sexes of the *Labrus mixtus* although very different in colour are beautiful the male being orange with bright blue stripes, and the female bright red with some black spots on the back

... *lienensia petenensis* [1] the dorsal fin is greatly developed and is marked with a row of large, round ocellated bright-coloured pots whilst the same fin in the female is smaller of a different shape and marked only with irregularly curved brown spots In the male the basal margin of the anal fin is also a little produced and dark coloured In the male of an allied form the *Xiphophorus Hellerii* (fig 30) the inferior margin of the caudal fin is developed into a long filament which as I hear from Dr Günther is striped with bright colours This filament does not contain any muscles and apparently cannot be of any direct use to the fish As in the case of the Callionymus the males whilst young resemble the

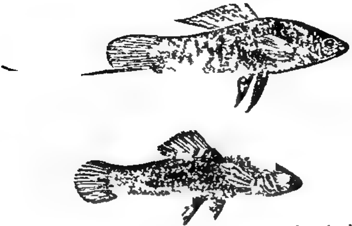
[11] I h ... draw up this descr pti n from Yarrell's *Brit h F shes* v l i 1836 pp 261 d 266

... *r* July 1873 p 264

Catalogue f Acanth. F hes in the British Museum by Dr Günther 1861 pp 138-151

[13] *Game Birds f Sweden, &c* 1867 p 466

[14] With respect t th ... the f ll ... g pec es I am ... d bt d to D ... see als his pape ... Fish f C ... tr l Am rica, *T ns t Zoolog al Soc* ... 1868 p 485



F o. 30 X *phophorus hellers* Upper figure male low figure f male.

adult f male in colour and struct re. Se ual differences such as these may be trictly com pared th those which are so freq nt with gallinaceous birds.

In siluroid fish, inhab ting th fresh w t rs of South Am rica, th *Plecostom barbatus*[10] (f 31) the male has t m th and inter perculum fringed with beard f tiff hairs, of hich th f male shows hardl trace These hairs re of th nature f scales. In anothe species of th sam g us, soft flexible tentacles project from th fro t part f th head of th male, which re abse t in th f male These t tacles are prolo g tions of th true skin, and th ref re are not h m l g us with th stiff hairs of th f rm species b t t can hardl be d bted that both serv th sam purpose What this purpose may be is difficult to co jecture rnam nt does not here seem probal le b t w can hardl ppose that tiff hairs and fl xible filament can be seful to any ordinary w to th males alone. I that strang m nst th *Ch mær mon strosa*, th male has hook shaped bo o the top of th head, directed f rwards, w th ts nd rounded and co red with sharp spines in the f male this cro n is alt gethe abse t, b t hat ts use ma be to th mal is tt ly unknown[11]

Th tru tures as et ref rred to are per man nt in th mal aft r he has arr ed t maturity b t with some blenn s, and in anoth allied g nus,[12] a crest is d l ped on th h ad f th male nly d rin th breeding season, and the bod at ll sam time becomes m re brightly-col ured Th re can be l ttle d ubt that this rest serves as a temporary sexual rnam t, f th f male does not xhib t trace f it. In th species of th same genus both se es possess a crest, and n at least peci n the se is th s pro ided In many f the Chromidæ fo instance in Geophagu and especially in C chla, th mal s, as I hear from Professo Agassiz, ha a con p cu protuberance n th forehead wh ch is wh lly wantin in th f males and in th ung males. Professor Agassiz adds, I ha e ft n observed these fishes t the time of pawning wh th protuberance is largest and t other seasons wh n t is t tall want ing and th tw se sh w n diff re ce what in th tline of th profile of the head I could ascertain th t t b e es any special function, and th Indians n th Amazon know n thing abo t ts use" These protube ance resembl in their periodical ppearance th flesh carbuncles n the heads f certain birds but wh th th ey serv as rnam nts must remain t present d ubtful.

I hear from Professo Agassiz and D Gun ther that th males f those fishes, which

[10] Dr Günther makes this remark, *Catalogue f Fishe the British M seum* vol iii., 1861 p. 141

[11] See Dr Günther this g nus, *Proceed g of the Zoological Society*, 1868, p. 232.

[11] F Buckland, *Land nd Water* July 1868, p. 377 th figure Many other cases could be added of structures peculiar t the male, of hich the uses are not known.

[12] Dr Gü ther *Catalogue of Fishe* vol iii., pp 221 nd 240.

[13] See also *A J urney B azil*, by Prof. and Mrs. Agassiz, 1868, p. 220.

Fig. 31. *Pl*[illegible]
Upper figure [illegible] figure female.

differ permanently in colour from the females, often become more brilliant during the breeding season. This is likewise the case with a multitude of fishes, the sexes of which are identical in colour at all other seasons of the year. The tench, roach, and perch may be given as instances. The male salmon at this season is marked on the cheeks with orange-coloured stripes, which give it the appearance of a Labrus, and the body partakes of a golden orange tinge. The females are dark in colour, and are commonly called black fish.[22] An analogous and even greater change takes place with the *Salmo eriox* or bull trout; the males of the char (*S. umbla*) are likewise at this season rather brighter in colour than the females.[23] The colours of the pike (*Esox reticulatus*) of the United States, especially of the

[22] Yarrell, *History of British Fishes*, vol. [illegible] 1836, pp. 10, 1[illegible], 35.

[23] W. Thompson, in *Annals and Magazine of Natural History*, vol. [illegible] 1841, p. 440.

male become, d rin th breeding-season, exceedingly intense brilliant and iridescent.[4] Another striking instance o t of man is af forded by th mal stickleback (*G terosteus leurus*) which is described b M Waring ton, as being th n be tif l bey nd d scrip tion. The back and es f th f m l are simply brown and th belly white. Th of the male on th th r hand, are f th most splendid green, ha ing a m tallic l tre like the gree f th rs f som humming birds. Th throat and bell are of bright crimson, th back f an ash green, and th whole fish ppears as tho h t w re som what trans luce t and glowed with an int rnal incan descence. Aft th breeding season these colours all change th throat and belly become pale red, th back m re green, and th glowing tints subsid

W th respect th courtship of fish s, othe cases ha bee observed since th first ed t of this book ppeared besides th t alread p of th tickleback. Mr W S h t says that the male of th *Labru mixt* wh h, as w ha seen, diff rs in col from th f mal makes deep hollow in th sand of th tank, and the ndea rs in th most persuasi mann to ind ce f mal of th sam species t share t th him wimmin ba kwards and f rward betwee h and th compl ted nest,

leaden-black th th n retire from th sl oal, and ca t hollow as n t. Each mal now mo t gilant guard his respecti

tended w th pawn, and th se h d urs b all tl m ans t po t l re san l t his prepared hollow and th re to d posit th myriad with which th are lad n, which he the protects and guard with th greatest care "[2]

A more triking case of co rtsh p as w ll as of di pla by th males of Ch ese Macropus has been b M Carbonn who care fully observed these fishes nd confin m t.[3] The males are most be tifull coloured more so than the females. During th breeding se son th y contend f r the possessi n of tl e fe males and, in the a t of courtship expand th fins, which are spotted and rname ted with bri htly coloured ra s, in the same man n according t M. Carbonn as tl e pea cock. Th y th n lso bound about th f males w th m h acit and appear by *l' talage d leur rire couleurs chercher a attirer l'at tention de f m ll le q lle ne pa a nt nd fferent m nfy l e nag ut rec ne molle lenteu les mal mbl u e compla d ns le ge* Aft the male has w n his bride he makes a littl disc f froth by blowing ai and mucus out f hi m uth He th n collects the f rtilised o a, dropped by th f mal in hi m th and thus

hab t h riginated b t th diffi ult much diminished when w kn w that th re are fi hes which thus collect and carry th gg f if d la ed b any ause in d pos ting th m th hab t f h tching them in th ir m this might ha been acquired

To return t ur m re immedi t ubject Th case stand thus f mal fishes, as far as I can l arn, n e willingl pawn cept n th prese ce f th mal and th males n f rtilise th cept in th presence f th f mal s. Th males fight f th possess of th f mal s. In many pecies, th males whil t ung resembl th f males in col ur b t wh n adult becom m ch m re brilliant and retain th ir col rs thro gh ut lif In ther spec es th males becom bri ht than th fe males and th rwise m re highl rnam ted nl l ring th season f l n. Th mal sed l sl court th f males, and in n case as w ha seen, tak pains in di playing th ir be ty bef re th m. Can t be beli ed that th y w uld thus act t n purpose d ring th ir courtship And thus w ld be th case unless th f males rt som ch ce and select tl se males wh h pl ase cit th m most. If th f m l rts ch h e all the abo facts on the rnam tat l th males becom once int lligibl b th aid of sexual selecti n.

[1] The America Agricult alist, 1868, p. 100
[2] Annals nd M g of Nat. Hist., Oct., 1852.
[3] Natur May 1 73, p. 25.
[4] Bull de la Société d' Accl mation, Paris, July 1869, and J n., 18 0.

We have next to mo

aw of the equal transmission of characters to both sexes be extended to those groups in which the males and females are brilliant in the same or nearly the same degree and manner In such a genus as Labrus which includes some of the most splendid fishes in the world—for instance the peacock Labrus (*L pavo*) describ

y accept this belief for we have seen that the sexes in at least one species of the genus differ greatly in colour With some fishes as with many of

ithout the aid of selection of any kind The gold fish (*Cyprinus auratus*) judging from the analogy of the golden variety of the common carp is perhaps a case in point as it may owe its splendid colours to a single abrupt variation due to the conditions to which this fish has been subjected under confinement It is however more probable that

d through has been

e period [20]

Under natural conditions it does not seem probable that beings so highly organised as fishes and which live under such complex relations should become brilliantly coloured without suffering some evil or receiving some benefit from so great a change and consequently without the intervention of natural selection

What then are we t co in regard to

el are splen

cheves that

quent re ls

and other brightly-coloured organisms abound are brightly coloured in order to escape detection by their enemies but according to my recollection they were thus rendered highly conspicuous In the fresh waters of the tropics there are no brilliantly-coloured corals or other organisms for the fishes to resemble yet many species in the Amazons are beautifully coloured and many of the carnivorous Cyprinidae in India are ornamented with bright longitudinal lines of various tints [21] Mr M'Clelland in describing these fishes, goes so far as to suppose that the peculiar brilliancy of their colours serves as a better mark for king fishers terns and other birds which are destined to keep the number of these fishes in check but at the present day few naturalists will admit that any animal has been made conspicuous as an aid to its own destruction It is possible that certain fishes may have been rendered conspicuous in order to warn birds and beasts of prey that they were unpalatable as explained when treating of caterpillars but it is not I believe known that any fish at least any fresh water fi

or which both sexes are brilliantly coloured is that their colours were acquired by the males as a sexual ornament and were transferred equally or nearly so to the other sex

We have now to consider whether when the male differs in a marked manner from the female in colour or in other ornaments, he alone has been modified the variations being inherited by his male offspring alone or whether the female has been specially modified and rendered inconspicuous for the sake of protection such modifications being inherited only by the females It is impossible to doubt that colour has been gained by many fishes as a protection no one can examine the speckled upper surface of a flounder and overlook its resemblance to the sandy bed of the sea on which it lives Certain fishes, moreover can through the action of the nervous system change their colours in adaptation to surrounding objects, and that within a short time [22] One of the most striking instances ever recorded of an animal being protected by its colour (as far as it can be judged of in preserved specimens) as well as by its form is

ricalry as to its old and as source f profit.
[20] *Westminster Review* Jul 1867 p 7

[21] Ind n Cyprin dae by M M'Clelland, *Asiatic Re* ... part ... 1839 p 230
[22] G ... ch ... 1871 p. 134

that given by D Gü th r[21] f p pe-fish, which, with ts reddish streami g filaments, hardly distinguishabl from the sea weed to hich t clings with ts preh nsile tail. B t th questio now und cons d rat on is wh th the females alo ha e been mod fied f thi object. We can see that se will not be modified thro gh natural selection f r the sak of protectio more than th oth supposing both to ary unless sex is exposed for longer period to dang has less powe of escaping from ch dang than th th and t does not ppear that with fish th sexes diff in these respects. As far as th re is any diff rence, th males, from being g n rally smaller and from wand ring more bo t, are sposed to gre te dang than the f males and yet, wh th se es diff the mal are almost alw ys th m re consp cu usly col ured Th o are f rtilised immediately afte l

pare ts, so that th mal and f mal s, as far as xposition is co cerned, are equally posed t dang and both are equall m portant f th prod t f f rt l co seq ently th more less brightl -colo red ndi iduals of th se w uld be eq ally liabl to be d stro ed preserved and both ould ha an equal fl nce n th col ur of thei offspri g

Certain fishes belo gin t se al famil es, mak nests, and som of th m tak care f th eir ung wh hatched Both sexes f the bright-coloured *Cre ilabrus massa* and *melops* ork t gether in b ilding their nests w th sea-eed, shells, &c[22] B t th males of certain fishes d all th w k, and aft rward tak ex lusi charge of th ung This is th case th the dull-colo red gob es,[23] in which th sexes are not kno n t differ in colo and likew se with th st klebacks (Gast rost) wi ich th male become brilliantly colo red d ring the spawni g seaso Th mal of th smoo th tailed stickl back (*G leiurus*) pe f rm th t es of rse with ex mplary care and vigilance d rin lo g tim and continual emplo ed in g tl leadin back th young to the nest, when they tray too far H courageously dri es aw y all en mi in-cl ding th f males of his own species. It w uld indeed be no small rel ef to the mal f th f mal aft d po ting h r eggs, were m medi t l d red b some enemy f r he f rced incessantly t drive h r from the e t.[24]

Th e males f certain th r fish es inhab ting South Am rica and Ce l n b lo ging to two distinct Ord rs, ha th e traordinary h b t of hatching within th m uth o bran hial ca t es, th egg laid b th females.[25] I am inf rmed b Prof sso Agass iz th t the males of th Amazonian pecies whi h f llow th hab t, "n t onl re g n ally brighte than th f mal s, b t th diff re ce s gre t r t the spawning season than at any othe time Th pecies of Geophagus act in the sam mann r and in this genus, a consp cu us prot berance becomes de loped n th f rehead f th males during the breeding season. With th var ous pecies of chromids, as Professor Agassiz lik wise inf rms m sexu l diff rences in colour ma be observed wh th r the l y thei gg n th w ter am g aquatic plant or d posit them in h es, l ing th m to come o t with t furth care build shallow n ts

r with all th species f chrom d it th mal al which sits n th ggs is not known It is, howev manifest that th fact of the ggs bein protected u protected b th parents, has had littl no infl ence th diff re ces in colour between th se es It is f rth manifest, in all th cases whi l th males tak clus charg f th t and un th t th destruction of the bri ht r col ured males w uld be far more infl ntial n th charact f th race, than th destruc tio f th brighte -coloured f males f the

[21] Proc Zoolog Soc 1865, p. 327 pls xi and xv

[22] Yarrell, British F he vol p. 11

[23] Accordi g t the observ tions of M Gerbe see Günther Record of Zoolog Literature 1865, p. 194

[24] See M W rren t most int rest g descrip-tio of th habits of th Gasterosteus le urus Annal and J gazine of Nat H story N ve ber 185

[25] Prof. Wyman, P oc Bosto Soc of Nat. Hist Sept. 1 1857 Also Prof Turner J rnal f Anatomy nd Physiology N 1 1866 S. D Günther has l kew se d scribed other cases.

[?] ver F se Animal. ol ii. 1 22 p. 212.

the males are more conspicuously coloured than the females

In most of the Lophobranchii (pipe fish Hippocampi &c) the males have either marsupial sacks or hemispherical depressions on the abdomen in which the ova laid by the female are hatched The males also shew great attachment to their young [3] The sexes do not commonly differ much in colour but Dr Gunther believes that the m ... e s

... ase ... for the female is much more vividly coloured and spotted than the male and she alone has a marsupial sack and hatches the eg... so that the female of Solenostoma differs from all the other Lophobranchii in this latter respect ...

... on of character in the female should be an accidental coincidence As the males of several fishes which take exclusive charge of the eggs and young are more brightly coloured than the females and as here the female Solenostoma tal... the same charge and ... brighter than the male it might be argued that the conspicuous colours of that sex which ... the more important of the two for the welfare of the offspring must be in some manner protective But from the large number of fishe... of which the males are either permanently or periodically brighter than th... males but ... ant for the ... the female ... When we treat of birds we shall meet with analogous cases where there has been a complete inversion of the usual attributes of the two sexes and we shall then give what appears to be the probable explanation namely that the males have elected the more attractive females instead of the latter having elected ... in accordance with the usual rule throughout the animal kingdom the more attractive mal s

On the whole we may conclude that with most fishes in which the sexes differ in colour or in other ornamental chara ter the males originally varied with their variation ... ansmitted to the same sex and accumulated through sexual election by attracting or exciting the females In many cases however such characters have been tran ferred either partially or completely to the females In other case again both sexes have been coloured alike for the sake of protection but in no instance does it appear that the female ... h s ...

... are known to make various noises, some of which are described as being musical Dr Dufosse who has especially attended to this subject says that the sounds are voluntarily produced in several ways by different fishes by the friction of the pharyngeal bones—by the vibration of certain muscles attached to the swim bladder which serves as a resounding board—and by the vibration of the intrinsic muscles of the swim bladder By this latter means the Trigla produces pure and long drawn sounds which range over nearly an octave But the most interesting case for us is that of two species of Ophidium in which the males alone are provided with a sound producing apparatus consisting of small movable bones with proper muscles in connection with the swim bladder The drumming of the Umbrinas in the F... be ... nd ... e ... n ... ing time and that it is possible by imitating it to take them without bait From this statement and more especially from the case of Ophidium it is almost certain that in this the lowest class of the Vertebrata as with so many insects and spiders sound producing instruments have at least in some cases, been developed through sexual selection as a means for bringing the sexes together

AMPHIBIANS

URODELA —I will begin with the tailed amphibians The sexes of salamanders or newts often differ much both in colour and structure In some species prehensile claws are developed on the fore legs of the males during the breeding season and at this season ... the male ...

353 ... m ... Th... e ... said by ... ut ... t ... s ... of the r ...

3 Yarrell History of British Fishes ... 1836 pp 329 338

... th ... of ... part ... ith ... d ... and ... Th ... C ... k ... May 1860 ... 40

Triton palmipes the hind feet are provided with swimmin web, which is almost completel absorbed durin th winter so that their feet the resembl those of th f male.[a] This structure no d ubt aid th mal in his eager search and pursuit of th f male Whilst courtin, her h rapidl vibrates the nd of his tail. W th our common newts (*Triton punctatus* and *cristatus*) a deep, much ind nted crest is

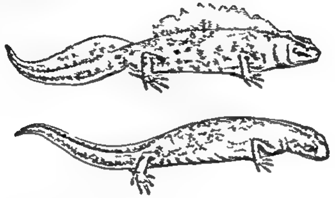


FIG. 32 *Triton cristatus* (half natural size, from Bell' *History of British Rept les*).
Upper figure male during the breeding seaso ; lower figure female

developed along th back and tail f th mal during the breeding season, which disappears during the wint Mr St Geor Mi art in forms me that t is not furnished w th m scles, and therefore cannot be used f locomotion. As durin the seaso of courtship t becomes ed ed with bright colours, there can hardly be doubt that t is masculine ornament. In man pecies the bod prese ts trongly contrasted, thou,h lurid tints, and these becom more vivid during th breedin, season. Th male for instance of our commo little n wt (*Trito punctatus*) is brownish-gre abo passing int llow bene th, which in th pring becomes rich bright rang, marked erv here th round dark pots. The ed of the crest also is then tipped with bright red or iolet The f male is usuall of a llo ishbro colour w th sca t red brown d ts, and the lo urface is oft quit plain.[b] The oun are obscurel tinted Th are f tilised d rin the act of deposit n, and are not subsequently tended by eithe parent. W may th ref re conclude that the males have acquired th ir tron l marked colours and ornamental ppendages throu,h sexual selecti n these being transmitted th r to th male off pring alone, r to both sexes.

ANUR OR BATR CHIA — W th man frogs and toads the colours id ntl serve as a protection, such as th bri ht green tints of tree frogs and the obscure m ttled shades of many terrestrial speci s. Th most conspicu usly-coloured toad which I ev saw th *Ph ynisc* *nigricans*[c] had th wh le ppe urface of th body as black as ink, with th soles of th feet and parts f th abd m n potted w th the brightest rmilion. It crawled about th bare sandy pen grass plains of La Plata und r a scorching un, and could n t fail to catch th f ry passin creature These col urs are probabl ben ficial b makin this animal known to all birds of prey as nauseous mouthful.

In Nicaragua th re is a littl fro, dressed in bright h rv of red and bl e whi h does not conceal tself lik most th species, but h p abo t durin, th d tim and M Belt sa that as soon as he saw ts happy sense of security h f lt sure th t t was u table. Aft se ral trials h succeeded in t mptin a un, d ck to snatch up a oung on b t t was instantl rejected and th d k w nt about j kin ts head as if tryin to throw off som unpleasant taste.

W th respect to sexual diff rences f colour

[a] B ll, *History of British Reptiles*, 2nd ed., 1 49, pp. 156-1 9.

[b] Bell, *History of British Reptiles*, 2nd ed., 1849, pp. 146, 151.

[c] *Zoology of the Voy of the Beagle* 1843. Bell, ibid., p. 49

[d] *The Naturalist Nicar gua*, 1874, p. 321

Dr Günther does not know of any striking instance either with frogs or toads yet he can often distinguish the male from the female by the tints of the former being a little more in tense Nor does he know of any striking difference in external structure between the sexes excepting the prominences which become developed during the breeding season on the front legs of the male by which he is enabled to hold the female [47] It is surprising that these animals have not acquired more strongly marked sexual characters for though cold blooded their passions are strong Dr Günther informs me that he has several times found an unfortunate female toad ... red ... ree ... ro ... orman in Giessen fighting all day long during the breeding season and with so much violence that one had its body ripped open

Frogs and toads offer one interesting sexual difference namely in the musical powers possessed by the males but to speak of music, when applied to the discordant and over whelming sounds emitted by male bullfrogs and some other species seems according to our taste a singularly inappropriate expression Nevertheless certain frogs sing in a decidedly pleasing manner Near Rio Janeiro I used often to sit in the evening to listen to a number of little Hylæ perched on blades of grass close to the water which sent forth sweet chirping notes in harmony The various sounds are emitted chiefly by the males during the breeding season as in the case of the croaking of our common frog [48] In accordance with this fact the vocal organs of the males are more highly-developed than those of the females In some genera the males alone are provided with sacs which open into the larynx [49] For instance in the edible frog (*Rana esculenta*) the sacs are peculiar to the males and become when filled with air in the act of c... e ... e ... whilst that of the female is only a slight groaning noise [50] In the several genera of the family th ... reon ... ent a ... ction

REPTILES

CHELONIA —Tortoises ... t ... in some the plastron or lower surface of the shell of the male is slightly concave in relation to the back of the female The male of the mud turtle of the United States (*Chrysem* ... t ... of the Galapagos Islands (*Testudo nigra*) the males are said to grow to a larger size than the females during the pairing season and at no other time the male utters a hoarse bellowing noise which can be heard at the distance of more than a hundred yards the female on the other hand never uses her voice [53]

With the *Testudo elegans* of India it is said that the combats of the males may be heard at some distance from the noise they produce in butting against each other [54]

CROCODILIA —The sexes apparently do not differ in colour nor do I know that the males fight together though this is probable for some kinds make a prodigious display before the females Bartram[55] describes the male alligator as striving to win the female by splashing and roaring in the midst of a lagoon swollen to an extent ready to ... ing his feats of war During the season of love a musky odour is emitted by the submaxillary glands of the crocodile and pervades their h... [56]

... knows of no other difference in external structure In regard to colour he can almost always distinguish the male from the female by his more strongly pronounced tints thus the black zigzag band on the back of the male

[47] T ... (Dr ... ...

[48] ... Bell History of British Reptiles 1849 p 93

[49] J Bishop in Todd's *Cyclopædia of Anatomy and Physiology* vol iv p 1503

[50] Bell, ibid pp. 112-114

[53] ... May ... Dec 1869 p ...

[54] See ... of Re... of the Voyage of the B... 1845 p 384

[55] Dr Günther Reptiles of British India 1864 p ...

[56] Travels through Carolina 1791 p 128

[56] Owen Anatomy of Vertebrates vol i 1866 p 615

English viper is more distinctly defined than in the female. The difference is much plainer in the rattle snakes of N. America, the male of which, as the keeper in the Zoological Gardens showed me, can at once be distinguished from the female by having more lurid yellow about its whole body. In S. Africa the *Bucephalus capensis* presents an analogous difference, for the female is never so fully variegated with yellow on the sides as the male.[*] The male of the Indian *Dipsas cynodon*, on the other hand, is blackish-brown, with the belly partly black, whilst the female is reddish or yellowish-olive, with the belly either uniform yellowish or marbled with black. In the *Tragops dispar* of the same country the male is bright green, and the female bronze-coloured.[*] No doubt the

... many places ... colours of many kinds, for instance of the common English snake and viper, serve to conceal them; and this is still more doubtful with the many foreign species which are coloured with extreme elegance. The colours of certain species are very different in the adult and young states.[*]

During the breeding season the anal scent glands of snakes are in active function;[*] and so it is with the same glands in lizards, and as we have seen with the submaxillary glands of crocodiles. As the males of most animals search for the females, these odoriferous glands probably serve to excite or charm the female, rather than to guide her to the spot where the male may be found. Male snakes, though appearing so sluggish, are amorous; for many have been observed crowding round the same female, and even round her dead body. They are not known to fight together from rivalry. Their intellectual powers are higher than might have been anticipated. In the Zoological Gardens they soon learn not to strike at the iron bar with which their cages are cleaned; and Dr. Keen of Philadelphia informs me that some snakes which he kept learned after four or five times to avoid a noose, with which they were at first easily caught. An excellent observer in Ceylon, Mr. E. Layard, saw[*] a cobra thrust its head through a narrow hole and swallow a toad. "With this encumbrance he could not withdraw himself; finding this, he reluctantly disgorged the precious morsel, which began to move off; this was too much for snake philosophy to bear, and the toad was again seized, and again was the snake, after violent efforts to escape, compelled to part with its prey. This time, however, a lesson had been learnt, and the toad was seized by one leg, withdrawn, and then swallowed in triumph."

The keeper in the Zoological Gardens is positive that certain snakes, for instance Crotalus and Python, distinguish him from all other persons. Cobras kept together in the same cage apparently feel some attachment towards each other.[*]

It does not, however, follow because snakes have some reasoning power, strong passions and mutual affection, that they should likewise be endowed with sufficient taste to admire brilliant colours in their partners, so as to lead to the adornment of the species through sexual selection. Nevertheless, it is difficult to account in any other manner for the extreme

... well remember how much surprise I felt at the beauty of the first coral-snake which I saw gliding across a path in Brazil. Snakes coloured in this peculiar manner, as Mr. Wallace states on the authority of Dr. Günther,[*] are found nowhere in the world except in S. America, and here no less than four genera occur. One of these, Elaps, is venomous; a second and widely distinct genus is doubtfully venomous, and the other two are quite harmless. The species belonging to these distinct genera inhabit the same districts, and are so like each other that no one but a naturalist would distinguish the harmless from the poisonous kinds." Hence, as Mr. Wallace believes, the innocuous kinds have probably acquired their colours as a protection, on the principle of imitation; for they would naturally be thought dangerous by their enemies. The cause, however, of the bright colours of the venomous Elaps remains to be explained, and this may perhaps be sexual selection.

[*] Sir Andrew Smith, *Zoology of S. Africa: Reptilia*, 18[illegible], pl. x.

[*] Dr. A. Günther, Reptiles of British India, Ray Soc. 1864, pp. 304, 308.

[*] Dr. Stoliczka, *Journal of Asiatic Society of Bengal*, vol. xxxix, 1870, pp. 205, 211.

[*] Owen, *Anatomy of Vertebrates*, vol. i., 1866, p. 615.

[*] "Rambles in Ceylon," in *Annals and Magazine of Natural History*, 2nd series, vol. ix., 1852, p. 333.

[*] Dr. Günther, *Reptiles of British India*, 1864, p. 340.

[*] *Westminster Review*, July 1, 1867, p. 32.

Dr Günther does not know of any striking instance either with frogs or toads yet he can often distinguish the male from the female by the tints of the former being a little more intense Nor does he know of any striking difference in external structure between the sexes excepting the prominences which become developed during the breeding season on the front legs of the male by which he is enabled to hold the female [57] It is *surprising that these* animals have not acquired more strongly marked sexual characters for though cold blooded their passions are strong Dr Günther informs me that he has several times found an unfortunate female toad dead and smothered from having been so closely embraced by three or four males Frogs have been observed by Professor Hoffman in Giessen fighting all day long during the breeding season and with so much violence that one had its body ripped open

Frogs and toads offer one interesting sexual difference namely in the musical powers possessed by the males but to speak of music when *applied to the discordant and overwhelming* sounds emitted by male bullfrogs and some other species seems according to our taste a singularly inappropriate expression Nevertheless certain frogs sing in a decidedly pleasing manner Near Rio Janeiro I used often to sit in the evening to listen to a number of little Hylæ perched on blades of grass close to the water which sent forth sweet chirping notes in harmony The various sounds are emitted chiefly by the males during the breeding season as in the case of the croaking of our common frog [58] In accordance with this fact the vocal organs of the males are more highly-developed than those of the females In some genera the males alone are provided with sacs which open into the larynx For instance in the edible frog (*Rana esculenta*) the

g ou a u uuu — o

of the head near the corners of the mouth The croak of the male is thus rendered exceedingly powerful *whilst that of the female is* only a slight groaning noise [59] In the several genera of the family the vocal organs differ considerably in structure and their development in all cases may be attributed to sexual selection

REPTILES

CHELONIA —Tortoises and turtles do not offer well marked sexual differences In some species the tail of the male is longer than that of the female In some the plastron or lower *surface of the shell of the male is slightly* concave in relation to the back of the female The male of the mud turtle of the United States (*Chrysemys picta*) has claws on its front feet twice as long as those of the female and these are used when the sexes unite [60] With the huge tortoise of the Galapagos Islands (*Testudo nigra*) the males are said to grow to a larger size than the females during the pairing season and at no other time the male utters a hoarse bellowing noise which can be heard at the distance of more than a hundred yards the female on the other hand never uses her voice [61]

With the Testudo elegans of India it is said that the combats of the males may be heard at some distance from the noise they produce in butting against each other [62]

CROCODILIA —The sexes apparently do not differ in colour nor do I know that the males fight together though this is probable *for*

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to an extent ready to burst with its head and tail lifted up he springs or twirls round on the surface of the water like an Indian chief rehearsing his feats of war During the season of love a musky odour is emitted by the submaxillary glands of the crocodile and pervades their haunts [64]

OPHIDIA —Dr Günther informs me that the males are always smaller than the females and *generally have longer and slenderer tails* but he knows of no other difference in external structure In regard to colour he can almost *always distinguish the male from the female* by his more strongly pronounced tints thus the black zigzag band on the back of the male

J Bisl p 1 1oud ᴗ ᵖ
Physiol gv l. iv p 1 03
[58] B ll, *ibid* pp 112-114

Mr C J M y ul th Am ric n Nat a. st, U 1869 p
[61] — y J l f I l d g th Voyage f tl B gl 184 p 384
[62] D Gü tl *R ptil f Brit h I d* 1864 p
T l tl gh (ol d 1 01 p 128
[64] O l to y f V t b t v l. i 1866 p 615

animal is xcited Th y occ r i both se es, b t are best de l ped wh tl mal ar i s t mat nty t which th m ddl ppe d ge is som time tw ce as l ng as the head Most of th peci lik wise h e a l w re t h eck d this is much m re

during th pring and if on is caught, th the falls from the tree t th ground and allow tself to be capt ed w th impunity —I presum from d pair [88]

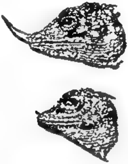

FIG. 54 *Ceratophor stoid ti* Uppe figure, male l wer figure f mal

In the g nus Chamæleon we come t the acm f d ff rence t tween tl sex s. Th uppe pa t of the kull f tl mal *C b furcus* (fig 5) an nh b tant f Mad gasc s pro- t sol d bony project

Chamæle owen (fig 6) from th t Wes f Afr ca the mal b ars on h nout an l f reh ad three curi us h rn f wh ch the f male has n t a trace Th se h rn consist f an resce ce f bone co red th a mooth th f rming pa t f th g n ral int gume ts f the body so th t th y are de t cal in truct re w th th se f a b ll g at r ot l ath h ed rum ant Alth gh th three h rns d ff r so much n ppe rance from the two gre t prol g ti ns f th kull n *C b f rcus* w can hardly d ubt th at they serv the same g eral p rpose n th eco omy f th se two animals. Th first conjecture which will occur t ry one s th t they are used by th mal s fo fight g t g th r and as th se an m ls are ry q arrelsome th i rob bly co rect vi w M T W Wood

re ted f a time and aft rward continued th b tl

W th many l rd the se d ff l ghtly in col th tints and tr pe f th males b brighter and m e dist tly d fi ed than in th f m l Th s, f in tance the case w th th abo Coph ti d w th th l *thodact yl pensis* f S Africa. In a C d yl f th l tt co ntry th m l

colo b t ass m g rpl sh ti t wl H animal cited In th ad lt m l f th l t te pec th h rn half an ch l gth, b t t is f quit min t size in th f mal d th y g These ppendag s, as D Gü ther has remarked t m y be compared th th comb f gallinaceo b rds, and ppare tly serv as *rn m ts*.

ri pa) th d sid f th body nd ba f th t l th mal ar b ght ang pot ted w th black in th f m l th se parts re pal g l gree w th t pot W h see that th n l al f S tan pos ess a throat po ch and this pl nd dly t nted w th bl black, and red In th *P oct t tus* f is f Chil th mal al s marked w th

All th foregoi g tat m ts d quot t s, re ard t Coph tus, tana nd Draco as ll as th folk g fact in regard t Cerat ph ra d Chamæleon, are from D Gü her himself from h mag ifice work the *R pt les of British I dia*, Ray Soc 1864 pp. 122, 130 135

[88] M S nhoe, *Proc. Zoolog Soc* 1870, p. 240

[89] D B hh lz, *M natsbericht k P eu Al d.* J 18 4 p 78.

B ll, *History f British Reptile* 2 d ed., 1849 p. 40

Snakes produce other sounds besides hissing The deadly *Echis carinata* has on its si les some oblique rows of scales of a peculiar structure with serrated edges and when this snake is excited these scales are rubbed against each other which produces a curious prolonged almost hissing sound [63] With respect to the rattling of the rattle snake we have at last some definite information for Professor Aughey states [64] that on two occasions being himself unseen he watched from a little distance a rattle snake coiled up with head erect, which continued to rattle at short intervals for half an hour and at last he saw another snake approach and when they met they paired Hence he is satisfied that one of the uses of the rattle is to bring the sexes together Unfortunately he did not ascertain whether it was the male or the female which remained stationary and called for the other But it by no means follows from the above fact that the rattle may not be of use to snakes in other ways as a warning to animals which would otherwise attack them Nor can I quite disbelieve the several accounts which have appeared of their thus paralysing their prey with fear Some other snakes also make a distinct noise by rapidly vibrating their tails against the surrounding stalks of plants and I have myself heard this in the case of a Trigonocephalus in S America

LACERTILIA —The males of some probably of many kinds of lizards fight together from rivalry Thus the arboreal *Anolis cristatellus* of S America is extremely pugnacious During the spring and early part of the summer two adult males rarely meet without a contest On first seeing one another they nod their heads up and down three or four times and at the same time expanding the frill or pouch beneath

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at each other furiously rolling over and over and holding firmly with their teeth The conflict generally ends in one of the combatants losing his tail which is often devoured by the

the general rule with lizards of all kinds The

male alone of the *Cyrtodactylus rubidus* of the Andaman Islands posses es ore anal pores and these pores judging from anal gy probably serve to emit an odour [66]

various

above

a crest

d can be

erected at pleasure but of this crest the female does not exhibit a trace In the Indian *Coph tu ceylanica* the female has a dorsal crest though much less developed than in the male and so it is as Dr Günther informs me with the females of many iguanas chameleons and other lizards In some pecies however the crest is equally developed in both sexes as in the *Iguana tuberculata* In the genus Sitana, the males alone are furnished with a large throat pouch (fig 33) which can be folded up like a

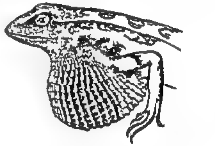


FIG 33 *S ta m or* M I w th the gular pouch p nded (fr m Gü th r *Rept l s of Ind*)

fan an l is coloured blue black and red but these splen lid colours are exhibited only during the pairing eason The female does not possess even a ru liment of this appendage In the *Anolis cristatellus* according to Mr Austen the throat pouch which is bright red marbled with yellow is present in the female though in a ru limental condition Again in certain other lizar ls both sexes are equally well provided with throat pouches Here we see with species belonging to tl e same group as in so many previous cases the same character either confined to the males or more largely developed in them than in the female or again equally developed in both sexes The little lizards of the genus Draco which glide through the air on their rib supported paracl ute and wl ich in the beauty of their col urs baffle description are furnished with skinny appendages to the tl roat like the wattles of gallinaceous birds These become erected when the

[63] Dr A d rson *P oc Zoolog Soc* 1871 p 196

[64] The *Americ* *N t* *Ist* 18 3 p 85

[65] M N L Aust n k pt th n ls al f a con der ble time see *Land nd W t* July 1867 p 9

[66] Stol ka, *J rnal f the Asiatic Society f B gal*, ol. 18 p 166

an mal is ted Th y occ r l tl se es, b t e best d l ped wl tl r le r s tmt ty t wl h ag tl e n lll pe d g r som t m s tw c as l g as tl l ad Most f tl pec l k se l e a l crest unn g alo g tl ck and tl s much m re d l ped tl e f ll g o n mal s th n r tl f mal r yo g mal s.

A Ch se peci s s sa d to l v pai dun g th pri g d if o e s caught tl tl falls from th tre to tl e g d an l all tself to b pt ed n th mpunity —I p es m from d pai

Fig 34 *Ceratophora stoddartii* Upper figure, male l figure f mal

sc o d pe es f tl sam t rm l sc l f rms min t h rn th m t f tl fl ble ppend d tl d f (*C stoddartii* fig 34) tl wl l ppendag con ted t to l rn wh l lly f l t col b t as m p l t t l mm l s ted I tl ad h m l f tl l t te pe th h rn h lf l gth b t t is quite min te n th f m l and tl y g. Tl se ppe dag as D Gu th has m ked to m may b comp ed th th comb f g ll aceo b d l f p tly serv as rn m t

In tl e g n Chamæleon we co ne t tl e acme f l t en tl e se fl e upp r g (fig 35) d ced into tw t so y cov ed with seal lk tl e r t f tl e l nd an l f tl is w l f l r od f t f tru t Il f male hib ts ly ru l t Again in *Chamæleon* s (fig 36) from tl e w t oa t f Afr a tl male l r l t a l f l ad tl ee u s l rn f wl h tl e f m le l as ot a trace Tl ese l n cor st t f r see ce f bo co re l w th a smootl al e tl f rm g p rt f tl g r l t gum t ts f tl l ly so tl t tl y d t t al r struct re w tl tl se f l ll g t otl r l tl l rn d rum a t Altl ugl tl e tl e l d ff r so n l t appe r nce from tl tw great f g tl f tl R ll m C b f rcu we t l rdly d l t tl t tl y serv the same g r l p rpose tl e eco my of tl se t o an ls lle f rst o jecture wl cl will occur to ry that tl y are used by tl l s f e figlt g t g tl r an l as th se als re y quar lso t tl s t prol l ly co rect w M F W Wood also t f ms m tl t le ce watcl ed two t d id l f C p m lus f glti g l t tly tl b l f tree tl y fl g tl r l ads abo t d t ed to b t acl tl er tl y tl n ted f a t me a d afterward co ti u d tl b ttl

W th m y l rd tl e se es d ff r l gl tly col u tl t ts d tripes f tl m l s b g b igl t nd m d t tly d f l ll tl f m l Tl f nsta tl e case tl tl bo Coj l t l w tl tl *A thodactyl* pe ts f S Af a. In a C lyl s f tl l tt r c t y tl m le is th m h dde g er tl tl f le I th I l C l t s n gril bns tl ere t ll g t d ff tl l p lso f tl m l black l l t th f tl fem l are gree I mm l ttl y l rd (*Z toca* p) tl l d f tl body d base f tl t l the m l b glt ge pot ted w tl black tl f m l tl p rt re p l g y l g w tl pot W h tl t tl l l l S tan po ss a ll t p l d tl pl d dly ti ted th bl black, d ed In th *L tot t s te* is f Cl l tl m le al e t m rked w tl

Mr Blanford, Proc Zoolog Soc 1870 p 240

D B hh l *Monatsbericht* K P Ak d J 1874 p 78

B ll *History of British Reptil* 2 d ed 1849 p 40

a es of a peculiar structure with serrated edges and when this snake is excited these scales are rubbed against each other which produces a curious prolonged almost hissing sound [63] With respect to the rattling of the rattle snake we have at last some definite information for Professor Aug hey states [64] that on two occasions being himself unseen he wat

u at last he saw another snake approach and when they met they paired Hence he is satisfied that one of the uses of the rattle is to bring the sexes together Unfortunately he did not ascertain whether it was the male or the female which remained stationary and called for the other But it by no means follows from the above fact that the rattle may not be of use to snakes in other ways as a warning to animals which would otherwise attack them Nor can I quite disbelieve the several accounts which have appeared of their thus paralysing their prey with fear Some other snakes also make a distinct noise by rapidly vibrating their tails against the surrounding stalks of plants and I have myself heard this in the case of a Trigonocephalus in S America

LACERTILIA —The males of some probably of many kinds of lizards fight together from rivalry Thus the arboreal *Anolis cristatellus* of S America is extremely pugnacious During the spring and early part of the summer two adult males rarely meet without a contest On first seeing one another th

eir eyes glisten with rage and after waving their tails from side to side for a few seconds as if to gather energy they dart at each other furiously rolling over and over and holding firmly with their teeth The conflict generally ends in one of the combatants losing his tail which is often devoured by the victor The male of this species is considerably larger than the female [65] and this is as far as Dr Günther has been able to ascertain is the general rule with lizards of all kinds The male alone of the *Cyrtodactylus rubidus* of the Andaman Islands possesses pre anal pores and these pores judging from analogy probably serve to emit an odour [66]

The sexes often differ greatly in vari in external characters The male of the above mentioned Anolis is furnished with a crest which runs along the back and tail and can be erected at pleasure but of this crest the female does not exhibit a trace In the Indian *Cophotis ceylanica* the female has a dorsal crest though much less developed than in the male and so it is as Dr Günther informs me, with the females of many iguanas chameleons and other lizards In some species however the crest is equally developed in both sexes as in the *Iguana tuberculata* In th

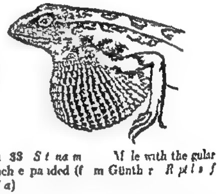


FIG 33 *S t na m* M le with the gular p uch e pa ided (f m Günth r *R pt l s f Ind a*)

fan and is coloured blue black and red but these plen li l colours are exhibited only dur

does not

endage In

Mr Austen the throat pouch which is bright red marbled with yellow is present in the female though in a rudimental condition Again in certain other lizards both sexes are equally well provided with throat pouches Here we see with species belonging to the same group as in so many previous cases the same character either confined to the males or more largely developed in them than in the female or again equally developed in both sexes The little lizards of the genus Draco which glide through the air on their rib supported parachute and which in the beauty of their colours baffle description are furnished with skinny appendages to the throat like the wattles of gallinaceous birds. These become erected when the

[63] Dr And rson *P oc Zool g Soc* 1871 p 196
[64] The *American Nat r l t* 1873 p 85
[65] Mr N L Austen k pt th se n m ls l f c de bl time see *Land nd W ter* July 1867 p 9
[66] St l c ka, *Journal f the Asiatic Society of B gal*, I xxxi 1870 p 166

CHAPTER XIII

SECONDARY SEXUAL CHARACTERS OF BIRDS

structure than any other class of animals. I shall, therefore treat the subject at considerable length. Male birds sometimes, though rarely possess special weapons for fighting with each other. They charm the female by vocal or instrumental music of the most varied kind. They are ornamented by all sorts of combs, wattles, protuberances, horns, air-distended sacks, top-knots, naked shafts, plumes and lengthened feathers gracefully springing from all parts of the body. The beak and naked skin about the head and the feathers, are often gorgeously coloured. The males sometimes pay their court by dancing, or by fantastic antics performed either on the ground or in the air. In one instance at least, the male emits a musky odour which we may suppose serves to charm or excite the female; for that excellent observer Mr. Ramsay says[1] of the Australian musk-duck (*Biziura lobata*) that "the smell which the male emits during the summer months is confined to that sex, and in some individuals is retained throughout the year; I have never, even in the breeding season, shot a female which had any smell of musk." So powerful is this odour during the pairing season, that it can be detected long before the bird can be seen. On the whole, birds appear to be the most aesthetic of all animals, excepting of course man, and they have nearly the same taste for the beautiful as we have. This is shown by our enjoyment of the singing of birds, and by our women, both civilised and savage, decking their heads with borrowed plumes, and using gems which are hardly more brilliantly coloured than the naked skin and wattles of certain birds. In man, however, when cultivated, the sense of beauty is manifestly a far more complex feeling, and is associated with various intellectual ideas.

Before treating of the sexual characters with which we are here more particularly concerned, I may just allude to certain differences between the sexes which apparently depend on differences in their habits of life; for such cases, though common in the lower, are rare in the higher classes. Two humming-birds belonging to the genus *Eustephanus*, which inhabit the island of Juan Fernandez, were long thought to be specifically distinct, but are now known, as Mr. Gould informs me, to be the male and female of the same species, and they differ slightly in the form of the beak. In another genus of humming-birds (Grypus), the beak of the male is serrated along the margin and hooked at the extremity, thus differing much from that of the female. In the Neomorpha of New Zealand there is, as we have seen, a still wider difference in the form of the beak in relation to the manner of feeding of the two sexes. Something of the same kind has been observed with the goldfinch (*Carduelis elegans*), for I am assured by Mr. J. Jenner Weir that the birdcatchers can distinguish the males by their slightly longer beaks. The flocks of males are often found feeding on the seeds of the teazle (Dipsacus), which they can reach with their elongated beaks, whilst the females more commonly feed on the seeds of the betony or Scrophularia. With a slight difference of this kind as a foundation, we can see how the beaks of the two sexes might be made to differ greatly through natural selection. In some of the above cases, however, it is possible that the beaks of the males may have been first modified in relation to their contests with other males; and that this afterwards led to slightly changed habits of life.

Law of Battle.—Almost all male birds are extremely pugnacious, using their beaks, wings and legs for fighting together. We see this every spring with our robins and sparrows. The smallest of all birds, namely the humming-bird, is one of the most quarrelsome. Mr. Gosse[2] describes a battle in which a pair seized hold of each other's beaks, and whirled round and round, till they almost fell to the ground; and M. Montes de Oca, in speaking of another genus of humming-bird, says that two males rarely meet without a fierce aerial encounter: when kept in cages their fighting has

[1] 'Ibis,' vol. iii. (new series) 1867, p. 414.
Gould, 'Handbook of the Birds of Australia,' 1865, vol. ii., p. 383.

[2] Quoted by Mr. Gould, 'Introduction to the Trochilidae,' 1861, page [illegible].

FIG 35 *Chamæleo b f rcus* Upper figure m le l er f gure f male.

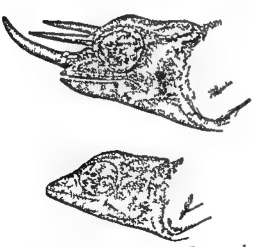


FIG 36 *Cl m l o u* Lpp f g ure m le
l er f g e f l

spot of blue green an l copper) red [11] In many cases the males retain the same colours througl out the year but in otl rs tl ey be come much brighter during the breedi g sea son I
Calotes
red head t e rest of bo y o

Both sexes of many species are beautifully coloured exactly alike and there is no reason to sup pose that such colours are protective No doubt with the bright green kinds which live in the midst of vegetation this colour serves to conce il them and in N I atagonia I saw a lizard (*I roctotretus multimaculatus*) wl ich when frightened flattened its body closed its eyes and then from its mottl l tints was hardly di tinguishable from the surroun in g sand But tl e bright colours with wl ich so many lizards are ornamented as well as their vario us curious appendages, were probal ly acquired by the males as n attraction and then transmitted eitl er to their male off pring or to l oth sexes Sexual selection indeed seems to have played alm st as important a part with reptiles as with l irds ar l the less conspicuous colours of the f males in comp ar i on with the males cannot be accounted for as Mr Wallace believes to be tl e case with birds, by tl e greater e po ure of the females to danger luring incul ation

[7] F
Beagl
of S \
\ dre
Calotes,
r p 143

I

[11] Gü th r I oc s *Zoolog l Society* 18 0, p 778 w tl l red f g re

snapping with th ir hu e beaks and g ing heavy bl w with th ir wing Male sn pe fight ... t ... g and pushing ach other

hens are f llo ed by ... n ball d z n ... t ... ir

(Bizur) and th male C nclo mphus cru at (all ed to ur p p ts) ar by m asurem t actu all t ice as large as th ir re pect f mal s. W th many th bird th f mal are larg r than th male and as f rm ly rema ked th planat ft n gi n, nam ly that th f males h m t f th w k in feeding th r ... ill t ffice I som f w cases, as w shall h realt see th f mal ppare tly ha acquired th ir gre te and t ngth f th sak f co q ri g th f mal and obtaining possess f th males

Th mal f many g ll naceo birds, s pec ally f th poly g m kind f rn hed w th pecial weapons f fighting w th th ir ri als, nam ly sp rs, which can b used with f arful ffect It has bee ecorded by trustw rthy write that in D rby hire kite struck ... gam h n accompanied by h chickens, when th cock ru hed to th esc e, and dro his pur right thro gh th ... and skull f th ggresso Th spur was w th diffi cult dr wn from th kull d as th kite, th gh d ad, retai ed his g a p th tw birds w re firml locked tog th but th cock wh n dise tangled was ry little inj red Th in incibl coura f th g m -cock n tori us ... tl man wh l ... g w t ssed th brutal

see b th p ... wo ld co tinu fight g Thi was nce ... the pot, and the b rd f ught w th und unted courag u til h recei ed his d ath troke In C ... l sely all ed w ld spec es, th *Gallus* ...

part dg (*Ortygornis g laris*) the ma wh ch is f rni hed w th tro g and sharp p rs, is so quarrelsom that the scars of f rmer fights disfigure the breast of almo t ry b rd y u kill ...

The male of alm t all gallinaceous birds, e n th se h ch are not f rn sl ed w th purs gag d ri g the breed g season in fi rce co fi ts. Th caperca l and l lack-cock (*T t ao u gall s* and *T tetri*) wl cl re both poly g mists, ha regular ppointed places, wh d ing many weeks th y co reg te n n mbers to fight t g th and to di play th r cha ms bef re th femal s. Dr W Ko ale ky inf rms m th t in R ssi h has seen the s w ll bloody n the ar nas wl e the caperca l ie h f ght and th black-cocks mak the f tl rs fly in ery d rect n wh n sev ral g g n a battl royal Th ld r Brehm gi es a curi acco t f th *bal*, as th l dance and lo so g f th l lack-cock are called n G rm Th b rd tt rs almo t co tin usly th trang t n se he h lds l is tail p and preads t t l k a fan, l lifts p his h ad and neck w th ll th f tl rs rect, and t t h s h w gs from tl body Then ll tak a f w j mp in d ff rent directi ns som tim rcl and p sses the und part f hi beak so hard ainst the gro nd that th chin feath rs ar rubbed off D ri g th se m m nts l be ts his w g and turn round and ro nd Th m re ard t h grow th m re l ly h becomes, u t l t last tl bird ppe l k frant re ture. At ch tim th black-cock ar so bso bed th t th y becom almost bli d and d af b t l ss so than th cape ca lzi b ce b rd aft b rd may b h t n th sam spot, n ca ght by the ha d Afte perf rm g th se t cs th mal b gin to fight and th sam black-cock, in rd to pro his st gth er se ral antag nists, will ... st in th course f

... H. ... ch mburgh, in *J rnal f Royal Geo g phic Society* ... 1843, p ...

... *Ornithological Biog phy* ... p. 191. F peli cans and nipes, see ... pp. 138, 477

... G uld, *H ndbook of Birds of Aust alia*, vol. i., p. 395 ... p. 383

... M Hew tt, in th *Poultry Book*, by T getmeier 1866 p. 137

Layard, *A nals nd M gazine f Nat al History* ... 1854 p 63

Jerd n, *B ds f India*, ... p. 574

mostly ended in the splitting of the tongue of one of the two which then surely dies from being unable to feed [4] With waders the males of the common water hen (*Gallinula chloropus*) when pairing fight violently for the females they stand nearly upright in the water and strike with their feet Two were seen to be thus engaged for half an hour until one got hold of the head of the other which would have been killed had not the observer interfered the female all the time looking on as a quiet spectator [5] Mr Blyth informs me that

day at a particular pot where the females propose to lay their eggs The fowlers discover these spots by the turf being trampled somewhat bare Here they fight very much like game-cocks seizing each other with their beaks and striking with their wings The great ruff of feathers round the neck is then erected and according to Col Montagu sweeps the ground as a shield to defend the more tender parts and this is the only instance known to me in the case of birds of any structure serving as a shield The ruff of feathers howe er from its

FIG 37 Th Ruff o *M cl t s pugn x* (from Brel m *Tl erl ben*)

the males of an allied bird (*Gallic cx cristatus*) are a third larger than the females and are so pugnacious luring the breeding season that they are kept by the natives of eastern Bengal for the sake of fighting Various other birds are kept in India for the same purpose for instance the bulbuls (*Pycn notus l æmorrhous*) which fight with great ...

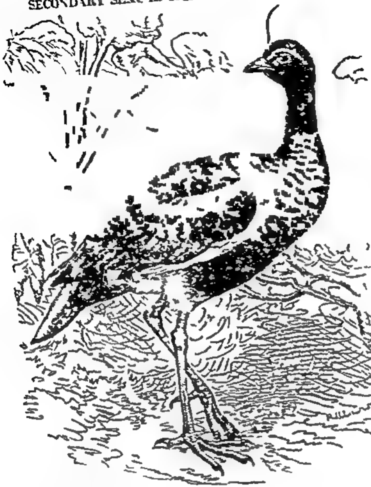
ar fig
y and
erably
larger than the females congregate day after

varied and rich colour probably serves in chief part as an ornament Like mo t pugnacious birds they seem always ready to fight and when clo ely conf ned often kill each other but Montagu observed that their pugnacity becomes greater during the pring when the long feathers on their necks are fully developed and at this period the least movement by any one bird p ovokes a general battle [7] Of the pugnacity of wel footed l ...

...-duck (*Cairina moschata*) and where these fights have occurred the river is

[4] G uld *bid* p 52.
[5] W Th mpso *Nat al H t y f I land B ds* vol i 1850 p 327
[6] Jerdon *B d f I d* 1863 vol p 96

[7] Ma g ll *r y H story f Brit h B d* vol iv 1852, pp 17 181



F G. 58 *Palam dea cornuta* (from Brehm), hewing the double wing-spurs and the filament on the head.

ı.g to Audubon, se ral males of the Vir ginian goat suck (*C primulgus ri gianus*) court, in highly tertaining mann the female and no sooner has she mad her choice than be pproved ▪ es chase to all intrud rs and dri es th m be ond his d minions. G nerall the males try to dri w or kill their ri als before they pair It does not, how er ppear that th females in ariabl pref the ictorious males. I ha indeed been assured b ▪ W ko al sk that the female caper cailzie sometimes steals w y with youn, male who has not dared to enter the arena with the lder cocks, in the sam mann as occasionally happens w th the does of the red deer in Scotland. When two males contend in presence of a single f male, the victor no doubt, commonl gains his desire b t some of these battle are caused by wand ring males tryin to distract th peace of an already

the male f such males are g n rally decor ated with arious ornam nts, which often becom more brilliant during the breeding season, and which are sedulously displa ed before th f males. Th males also end ur to charm excit their mates by lo e-notes, songs, and antics and the courtship is, in man

[5]Ornithological Biography vol. p. 275.

[6]Brehm, *Thierleben*, &c., B 1867 p. 990. Audubon, *Ornithological Biogr phy*, vol. ii., p. 492.

morning several bal. places which remain the same during successive years [14]

The peacock with his long train appears more like a dandy than a warrior but he some times engages in fierce contests the Rev W Darwin Fox informs me that at some little distance from Chester two peacocks became so excited whilst fighting that they flew over the whole city still engaged until they alighted on the top of St John s tower

The spur in those gallinaceous birds which are thus provided is generally single but Polyplectron (see fig 51 p 472) has two or more on each leg and one of the blood pheas ants (*Ithaginis cruentus*) has been seen with five spurs The spurs are generally confined to the male, being represented by mere knobs or rudiments in the female but the females of the Java peacock (*Pavo muticus*) and as I am in formed by Mr Blyth of the small fire backed pheasant (*Euplocamus erythropthalmus*) possess spurs In Galloperdix it is usual for the males to have two spurs and for the females to have only one on each l ... spurs may ... ure which ... ransferred ... Like most other secondary sex ual characters the spurs are highly variable both in number and development in the same species

Various birds have spurs on their wings But the Egyptian goose (Chen ...

... oped in other species In the spur winged goose *Plectropterus gambensis* the males have much larger spurs than the females and they use them as I am informed by Mr Bartlett in fighting together so that, in this case the wing spurs serve as sexual weapons but according to Livingstone they are chiefly used in the defence of the young The Palamedea (fig 38) is armed with a pair of spurs on each wing and these are such formi dable weapons that a single blow has been known to drive a dog howling away But it does not appear that the spurs in this case or in that of some of the spur winged rails are larger in the male than in the female [18] In cer

tain plovers however the wing spurs must be considered as a sexual character Thus in the male of our common peewit (*Vanellus cristatus*) the tubercle on the shoulder of the win be comes more prominent during the breeding season and the males fight together In some species of Lobivanellus a similar tubercle be comes developed during the breeding season into a short horny spur In the Australian *L lobatus* both sexes hav ... are ... al s

... ogether in the same manner as our peewits by turning suddenly in the air and striking sideways at each other sometimes with fatal results Thus also they drive away other enemies [19]

The season of love is that of battle but the males of some birds as of t ...

... presence of the female is the *teterrima belli causa* The Bengali baboos make the pretty little males of the amadavat (*Es trelda amandava*) fight together by placing three small cages in a row with a female in the middle after a little time the two males are turned loose and immediately a desperate battle ensues [20] When many males congregate at the same appointed spot and fight together as in the case of grouse and various other birds, they are generally attended by the females [21] which afterwards pair with ...

Brehm *Illu t Thie l ben*, 1867 ... v s. 351 S ... of the f rego ng tat m nts are t k n from L. Loyd *Game B rds f Sweden*, & 156 p 9 ... J don, *B ds of Ind* ... n Ithaginus, ... p 523 on C lloperd x p 541

For the Egyptian goose ee M gill ray *B itish B rds* ol iv p 639 F r Plectropt us, *L v g stone s T vels* p 254 F ... Palamed ... Br h n

Ill trierles Th erl ben, B iv ... 40 See also o th s bird Azar *Voy g ... d ns l Amériq ... méril* t m ... 1809 pp 179 253

See ... ur pe w t, Mr R C rr ... *La d nd Wate* A g 8 1868 p 46 In g rd t Lob ... llus, J d ... *B d f Ind* ... v l ... p 647 ... d G uld *H ndbook f B d f Aus* ... v l p 220 ... r tl ... H ... pterus ... ee Mr All n in the *Ibis* v l ... 1864 p 156

A dub ... *thologi al B og phy* ol ... p. 492 vol ... pp 4-13

M Blyth *Land nd W ter* 1867 p 212.

[20] R ch rdson ... *Tet ao mbell* ... *F ... na bor ... Am B d* 1831 p 343 ...

... e t k-cocks ... ept n t th co ... rul p ... ly th h y ... h ld n n th ... urr ... as is k ... n t b the case w th th grey h ... ca di n a, nd th th r pec ...

It is certain that there is an intense degree of rivalry between the males in their singing. Bird-fanciers match their birds to see which will sing longest; and I was told by Mr. Yarrell [illegible] bird will sometimes sing till h[illegible]

[illegible] during the season [illegible] of singing is sometimes quite independent of love is clear, for a sterile hybrid canary-bird has been described as singing whilst viewing itself in a mirror, and then dashing at its own image; it likewise attacked with fury a female canary, when put into the same cage. The jealousy excited by the act of singing is constantly taken advantage of by bird-catchers; a male in good song, is hidden and protected, whilst a stuffed bird, surrounded by limed twigs, is exposed to view. In this manner, as Mr. Weir informs me, a man has in the course of a single day caught fifty, and in one instance, seventy, male chaffinches. The power and inclination to sing differ so greatly with birds that although the price of an ordinary male chaffinch is only sixpence, Mr. Weir saw one bird for which the bird-catcher asked three pounds; the test of a really good singer being that it will continue to sing whilst the cage is swung round the owner's head.

That male birds should sing from emulation as well as for charming the female, is not at all incompatible; and it might have been expected that these two habits would have concurred, like those of display and pugnacity. Some authors, however, argue that the song of the male cannot serve to charm the female, because the females of some few species, such as of the canary, robin, lark, and bullfinch, especially when in a state of widowhood, as Bechstein remarks, pour forth fairly melodious strains. In some of these cases the habit of singing may be in part attributed to the females having been highly fed and confined,[20] for this disturbs all the functions connected with the reproduction of the species. Many instances have already been given of the partial transference of secondary masculine characters to the female, so that it is not at all surprising that the females of some species should possess the power of song. It has also been argued, that the song of the male cannot serve as a charm, because the males of certain species, for instance of the robin, sing during the autumn.[21] But nothing is more common than for animals to take pleasure in practising whatever instinct they follow at other times for some real good. How often do we see birds which fly easily, gliding and sailing through the air obviously for pleasure. The cat plays with the captured mouse, and the cormorant with the captured fish. The weaver-bird (Ploceus), when confined in a cage, amuses itself by neatly weaving blades of grass between the wires of its cage. Birds which habitually fight during the breeding-season are generally ready to fight at all times; and the males of the capercailzie sometimes hold their Balzen or leks at the usual place of assemblage during the autumn.[22] Hence it is not at all surprising that male birds should continue singing for their own amusement after the season for courtship is over.

As shewn in a previous chapter, singing is to a certain extent an art, and is much improved by practice. Birds can be taught various tunes, and even the unmelodious sparrow has learnt to sing like a linnet. They acquire the song of their foster parents,[23] and sometimes that of their neighbours.[24] All the common songsters belong to the Order of Insessores, and their vocal organs are much more complex than those of most other birds; yet it is a singular fact that some of the Insessores, such as ravens, crows, and magpies, possess the proper apparatus,[25] though they never sing, and do not naturally modulate their voices to any great extent. Hunter asserts[26] that with the true songsters the muscles of the larynx are stronger in the males than in the females; but with this slight exception there is no difference in the vocal organs of the two sexes, although the males of most species sing so much better and more continuously than the females.

It is remarkable that only small birds properly sing. The Australian genus Menura, however, must be excepted; for the Menura al-

[illegible]

[20] Naturg. d. der Stubenvögel, 1840, s. 252.
Mr. Bold, Zoologist, 1843-44, p. 659.
[21] D. Barrington, Philosophical Transactions, 1773, p. 262. Bechstein, Stubenvögel, 1840, s. 4.

[illegible] actions, 1773, p. 262.

instances a prolonged ff rr t

ou

u are probable that the females are excited either before or after the conflict by certain males and thus unconsciously prefer them In the case of *Tetrao umbellus* a good observer[?] goes so far as to believe that the battles of the male are all a sham performed to show themselves to the greatest advantage before the admiring females who assemble around for I have never been able to find a maimed hero and seldom more than a broken feather I shall have to recur to this subject, but I may here add that with the *Tetrao cupido* of the United States about a score of males assemble at a particular spot and strutting about make the whole air resound with their extraordinary noises At the first answer from a female the males begin to figh uriously and the weaker give way but then according to Audubon both the victors and vanquished earch for the female so that the females must either then exert a choice or the battle must be renewed So again with one of the field starlings of the United States (*Sturnella ludoviciana*) the males engage in fierce conflicts but at the sight of a female they all fly after her as if mad [4]

Vocal and instrumental music —With birds the voice serves to express various emotions such as distress fear anger triumph or mere happiness It is apparently sometimes used to excite terror as in the case of the hissing noise made by some nestling birds Audubon[25] relates that a night heron (*1 dea nycticorax* Linn) which he kept tame used to hide itself when a cat approached and then suddenly start up uttering one of the most frightful cries apparently enjoying the cat s alarm and flight The common domestic cock clucks to the hen and the hen to her chickens when a dainty morsel is found The hen when she has laid an egg repeats the ame note very often and concludes with the sixth above which she holds for a longer time [26] and thus she expresses her joy Some social birds pparently call to each other for ai l and as they fl t from tree to tree the flock is kept together by chirp answering chirp During the nocturnal migrations of geese and other water fowl, sonorous clangs from the van may be heard in the dark ness overhead answered by clang in the rear Certain cries serve as danger signals, which as the sportsman knows to l ~

c triumph over a defeated rival The true song however of most birds and various strange cries are chiefly uttered during the breeding eason an l serve as a charm r merely as a call note to the other sex.

Naturalists are much divided with re pect to the object of the singing of birds Few more careful observers ever lived than Montagu and he maintained that the males of song birds and of many others do not in general search for the female but on the contrary their busine s in the spring is to perch on some conspicuous spot breathing out their full and armorous notes, which by instinct, the female knows and repairs to the pot to choose her mate [?] Mr Jenner Weir informs me that this is certainly the case with the nightingale Bechstein who kept bird during his whole life asserts, that the female canary always chooses the best singer and that in a state of nature the female finch selects that male out of a hun lred whose notes please her mo t. [?] There can be no doubt that birds closely attend to each other s song Mr Weir has told me of the case of a bullfinch which had been taught to p pe a German waltz and who was so good a performer that he cost ten guineas when this bird was first introduced i to a room

t e greatest intere t to the new performer Many naturali ts believe that the si gin of birds is almo t exclu ively the effect of rivalry an l emulation an l not for the sake of charming their mates This v as the opinion of Daines Barrington and White of Selborne who both especially attended to this subject [?] Barrington however admits that superiority in song gives to birds an amazing ascer dar cy over others as is v ell kno n to bird-catcl ers.

14

p/ y n Tet ao

l p 219

p 601

[25] Th H n Daines B rri gt *Philosophical Transactions* 1773 p. 252.

[?] *O ul olog cal D t nary* 1833 p 4 5

[?] *N t p ch H d St ben g l* 1840 s. 4 Mr H rr so W l k nt t m l m n f rmed tl t th be t s g l g rally g t a m t first h n th y re bred n th sam room.

Philos ph al T ct ns 1 3, p. 263. Wh t s *N t al Hist y of S lbo ne* 1825 l. i., p. 246.

throat-pouch of the European male bustard (Otis tarda) and of at least four other species, does not, as was formerly supposed, serve to hold water, but is connected with the utterance during the breeding-season of a peculiar sound resembling "oak."[43] A crow-like bird inhabiting South America (*Cephalopterus ornatus*, fig. 40) is called the umbrella-bird, from its immense top-knot, formed of bare white quills surmounted by dark-blue plumes, which it can elevate into a great dome no less than five inches in diameter, covering the whole head. This bird has on its neck a long, thin, cylindrical fleshy appendage, which is thickly clothed with scale-like blue feathers. It probably serves in part as an ornament, but likewise as a resounding apparatus; for Mr. Bates found that it is connected "with an unusual development of the trachea and vocal organs." It is dilated when the bird utters its singularly deep, loud and long sustained fluty note. The head-crest and neck-appendage are rudimentary in the female.[44]

The vocal organs of various web-footed and wading birds are extraordinarily complex, and differ to a certain extent in the two sexes. In some cases the trachea is convoluted, like a

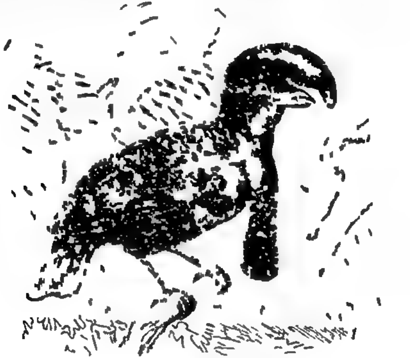


Fig. 40. The Umbrella-bird or *Cephalopterus ornatus*, male (from Brehm).

French horn, and is deeply embedded in the sternum. In the wild swan (*Cygnus ferus*) it is more deeply embedded in the adult male than in the adult female or young male. In the male Merganser the enlarged portion of the trachea is furnished with an additional pair of muscles.[45] In one of the ducks, however, namely *Anas punctata*, the bony enlargement is only a little more developed in the male than in the female.[46] But the meaning of these differences

[43] The following papers have been lately written on this subject: Prof. A. Newton, in the *Ibis*, 1862, p. 107; Dr. Cullen, ibid., 1865, p. 145; Mr. Flower, in *Proc. Zool. Soc.*, 1865, p. 747; and Dr. Murie, in *Proc. Zool. Soc.*, 1868, p. 471. In this latter paper an excellent figure is given of the male Australian bustard in full display with the sack distended. It is a singular fact that the sack is not developed in all the males of the same species.

[44] Bates, *The Naturalist on the Amazons*, 1863, vol. ii, p. 284. Wallace, in *Proceedings, Zoological Society*, 1850, p. 206. A new species, with a still larger neck-appendage (C. penduliger), has lately been discovered, see *Ibis*, vol. i, p. 457.

[45] Bishop, in Todd's *Cyclopaedia of Anatomy and Physiology*, vol. iv, p. 1499.

[46] Prof. Newton, *Proc. Zoolog. Soc.*, 1871, p. 651.

berti which is about the size of a half grown turkey not only mocks other birds but its own whistle is exceedingly beautiful and varied The males congregate and form cor *roborying* places where they sing raising and spreading their tails like peacocks and drooping their wings [39] It is also remarkable that birds which sing well are rarely decorated with brilliant colours or ot[illegible]

[illegible] bee eater roller hoopoe wood peckers &c utter harsh cries and the brilliant birds of the tropics are hardly ever songsters [40] Hence bright colours and the power of song seem to replace each other We can perceive that if the plumage did not vary in brightness, or if bright colours were dangerous to the species other means would be employed to charm the females and melody of voice offers one such means

In some birds the vocal o[illegible] y [illegible]) [illegible] on each side of the neck and these are largely inflated when the male during the breeding season makes his curious hollow sound audible at a great distance Audubon proved that the sound was intimately connected with this apparatus (which reminds us of the air sacks on each side of the mouth of certain male frogs) for he found that the sound was much diminished when one of the sacks of a tame bird was pricked and when both were pricked it was altogether stopped The female has a somewhat similar though smaller naked space of skin on the neck but this is not capable of inflation [41] The male of another kind of grouse (*Tetrao urophasianus*) whilst courting the female has his bare yel low œsophagus inflated to a prodigious size fully half as large as the body and he then utters various grating deep hollow tones. With his neck feathers erect his wings lowered and buzzing on the ground and his long pointed tail spread out like a fan he displays a variety of grotesque attitudes The œsophagus of the female is not in any way remarkable [42]

FIG 39 *Tetrao cupido* male (T W Wood)

It seems now well made out that the great

[39] Gould *Handbook of the Birds of Australia* [illegible] 1865 pp 308-310 See also Mr T W Wood in the *Student* April 1870 p 125

[40] See remarks [illegible] th[illegible] effect in Gould *Introduction to the Trochilidæ* 1861 p 22.

[41] *The Sportsman and Naturalist in Canada*, by Major W Ross King 1866 pp 144 146 Mr T W Wood gives [illegible] *Student* (April 1870 p 116) an excellent account of the [illegible] and habits of this bird during [illegible]

[42] [illegible] *bid.* [illegible] p 507

throat pou h f th E ropean mal bustard (*Otis tard*) and f t l ast f u tl r spec es, does ot, as was f rme ly upposed serve to h ld t b t s connected w th tl e utte ance dun g tl breed g season f a pecul ar sound resembling oak " A crow lik b rd in hab ting So th Am rica (*C p alopterus o natus* fig. 40) i called the umbrella bird from ts immense t p knot, f rmed of bar white

d l pme t of the trachea and vocal organs It is d l ted wh n the b rd utt rs ts singul rly deep l d and l g s tain ed fluty n te The head-er t and neck appe al g are rudim n tary in th femal [44]

The vocal organs of vario s web-footed and wad g b rds are xtraordi arily compl x and diffe a certain e tent in th two se es. In som case the trach a is con oluted lik a

FIG. 40 Th Umbrella bird *C ph lopteru ornat* male (from Brehm)

quills m ted by d k bl plumes wh ch t can l ate into gr t d m o l ss than fi in b diam t co n g th wl l h ad Th t rd has ts neck a l g thin, ylindri al fleshy ppend g which is thickly clothed th scal lik bl f th rs. It probably se part as an rnam t, but likese as resounding ppar tus f Mr B tes f und th t t is connected th an unusual

F nch h rn and deeply mbedded in the cles [45] In f th d ks, h w er n m ly *A as p t ta*, the b y nlarg m t is nly a littl m re d l ped in th mal th n n th f male.[46] B t th m an g f these diff rences

[44] The f llo g papers ha bee lat ly wr tt th subject Prof A. Newton, th *Ibis* 1862, p 107 D Culle ibid., 1865 p 145 M Flo Proc Zool. Soc 1865 p. 747 d D Murie in Proc Zool. oc 1868, p. 471 In this latt paper an cell t figure is gi of th mal Australia bustard f ll d play w th the sack d t ded It is gular fact that the sack is not d loped in all the males of the sam pecies.

[46] Prof N wton, *P oc. Zoolog* Soc., 1871 p 651.

in the trachea of the two sexes of the Anatidæ is not understood for the male is not always the more vociferous thus with the common duck the male hisses whilst the female utters a loud quack.[47] In both sexes of one of the cranes (*Grus virgo*) the trachea penetrates the sternum but presents certain sexual modifications In the male of the black stork there is also a well marked sexual difference in the length and curvature of t[illegible] y

[illegible] ue
[illegible] s and notes uttered by male birds during the breeding season serve as a charm or merely as a call to the female The soft cooing of the turtle dove and of many pigeons it may be presumed pleases the female When the femal of [illegible] ut [illegible] vers [illegible] oise [illegible] with erected feathers rustling wings and distended wattles he puffs and struts before her The *spel* of the black cock certainly serves as a call to the female for it has been known to bring four or five females from a distance to a male under confinement but as the black cock continues his *spel* for hours during successive days and in the case of the capercailzie with an agony of passion we are led to suppose that the females which are present are thus charmed.[50] The voice of the common rook is known to alter during the breeding season and is therefore in some way sexual.[51] But what shall we say about the harsh screams of for instance some kinds of macaws have these birds as bad taste for musical sounds as they apparently have for colour judging by the inharmonious contrast of their bright yellow and blue plumage It is indeed possible that without any advantage being thus gained the loud voices of many male birds may be the result of the inherited effects of the continued use of their vocal organs when excited by the strong passions of love jealousy and rage but to this point we shall recur when we treat of quadrupeds.

We have as yet spoken only of the voice but the males of various birds practise, during their courtship what may be called instrumental music Peacocks and birds of paradise rattle their quills together Turkey-cocks scrape their wings against the ground and some kinds of grouse thus produce a buzzing sound Another North American grouse, the *Tetrao umbellu*[illegible] when with his tail erect, his ruffs displayed he shows off his finery to the females who lie hid in the neighbourhood drums by rapidly striking his wings together above his back according to Mr R. Haymond and not, as Audubon thought, by striking them against his sides The sound thus produced is compared by some to distant thunder and by others to the quick roll of a drum The female never drums but flies directly to the place where the male is thus engaged The male of the Kalij pheasant, in the Himalayas, often makes a singular drumming noise with his wings not unlike the sound produced by shaking a stiff piece of cloth [illegible] On the west coast of Africa the little black weavers (Ploceus) congregate in a small party on the bushes round a small open space and sing and glide through the air with quivering wings, which make a rapid whirring sound like a child's rattle One bird after another thus performs for hours together but only during the courting season At this season and at no other time the males of certain night jars (Caprimulgus) make a strange booming noise with their wings The various species of woodpeckers strike a sonorous branch with their beaks with so rapid a vibratory movement that the head appears to be in two places at once The sound thus produced is audible at a considerable distance but cannot be described and I feel sure that its source would never be conjectured by any one hearing it for the first time As this jarring sound is made chiefly during the breeding season it has been considered as a love song but it is perhaps more strictly a love-call The female when driven from her nest has been observed thus to call her mate who answered in the same manner and soon appeared Lastly the male Hoopoe (*Upupa epops*) combines vocal and instrumental music for during the breeding season this bird as Mr Swinhoe observed first draws in air and then taps the end of its

[illegible] u t
[illegible] sent, o th t pe h ps th y re n w te d g t ards bort n

[48] *Element f C mpa at A t my* by R W g n r Eng translat. 1845 p 111 W th re pect to th swan gi abo Y rrell *H to y f Brit h B d* 2 d ed t o 1845 v l. p 193

C L. Bon parte, qu ted in the *Nat alist L b ary B d* v l. xi p 126

L. Ll yd *Th Gam B d f Sw den, &c* 1867 pp 22 81

[51] Jenner *Philosophical T nsact ns* 1824 p 20

beak perpend cularly down agai st sto e o the trunk f tree wl n tl b e tl be ng forced d n the t b lar b ll produce the cor rect sound. II th beak n t th s tru k against some bject, th so d i ut diff r t, tr is t th sam t e all wcd and tl e œsophagu th become m l sw ll n and th probably acts as a reso ato n t only th th hoopoe b t w th p geons and otl r birds.

In th f reg g cases so nd are mad by th ad of tru t already present and th rwise ecess y b t in tl e f ll g ase ce tain f th rs h e bee pec ally mod f ed f r the press p rpo f prod c ng sounds. The dr mming bl ti g n gl ing tl u le ing (as expressed by d ff re t bse) mad by th comm n sn pe (*Scolopax gal l g*) m th urprised e ery wl has h ard t. Tl b rd d i g tl pai g seaso fl t pe l p tl sand feet i h ght, and aft g zagg g bo t f r a t me desce d t th arth i urved l w th tspread tail and q g p n ns, and r p g loc ty Th so d i n tted nly d g th p d d see t. No was abl t xplai the se until M M bse ed that ach side f th tail the t f tl r

Fig. 41 O t tail f th f *Scol pax gall g* (from *Proceed g Zoologic l Society* 1858)

th se f tl rs, by fast g th m t a l g

S rry f Ind p 227 A d b 4m rie

1 k se mak th g cur us se during ts rapid flight.

tl n st k and w i g tl em r p dly tl rough th air l e could reprod ce th dru ming n made by tl e h ng b rd B th se are f rnisl ed w tl tl se fe tl rs, but tl ey are g rally l rge in tl n ale than in th fem l and en t a deeper n t In some peci s, as n *S f en ta* (fig 42) f ur feath rs, and in *S*

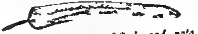


Fig 42 O t t lf th of *Scol pax f nata.*

F g 43 O t t lf th d *Scol pax javensis.*

j ens s (fig 43) n l ss tl an gl t n eacl de of tl e tail re g e tly modif ed D ff rent t s re tt d b the fe ther of the l ff

In th mal f tl e *Chamæpetes un color* (a larg gall acco s b rd f Am ri a) tl e f rst prim ry w g f ther s arcl ed towards tl t p and is m ch m re tten ated than n the f mal I a ll ed b rd the l n l pen gra, Mr Sal n obse ed a mal wl h, whl t

(*Syph ot d ritus*) has its p m a y g f tl rs gre tly acum ted and tl e n al f an all ed peci s kn w i to make a h mm g ise wl l t cou ti g tl fem l In w d ly d ff re t gro p f b rds, nam ly h m n g b rds, the m l alo e f ce ta n k nd ha th r th sl afts f th pri a y w g f th broadly d l ted or tl w bs abruptly c ed to ard the extrem ty The mal fo n tance of *S lasphorus platyc s* when dult, has th fi t p mary w g f the (fig 44) th sed Whilst flying from fl to fl wer h m kes a sh ll alm t

See M M t re t g p per P oc Zool. Soc 1858, p 199 F th h b ts f th pe M c gill y H tory f Brit h B d l p 371 F th Am ca pe, C pt. Bl k t Ibi l

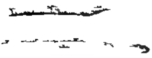


FIG 44 Prim ry wing feather of a humming bird the *Sel sphorus platycercus* (from a sketch by Mr Sal n) l pper figur th t of male lower figure corre p nding feather of fem le

whistling noise [34] but it did not appear to Mr Salvin that the noise was intentionally ma le

Lastly in several pecies of a sub genus of Pipra or manakin the males as described by Mr Sclater have their *secondary* wing feathers modified in a still more remarkable manner In the brilliantly-coloured *P deliciosa* the first three secondaries are thick stemmed and curved towards the body in the fourth and fifth (fig 45 a) the change is greater and in the sixth and seventh (b c) the shaft is thick ened to an extraordinary degree forming a solid horny lump The barbs also are greatly changed in shape in comparison with the cor responding feathers (d e f) in the female Even the bones of the wing which support these singular feathers in the male are said by Mr Fraser to be much thickened These little birds make an extraordinary noise the first sharp note being not unlike the crack of a whip [35]

The diversity of the sounds both vocal and instrumental made by the males of many birds during the breeding season and the di versity of the means for producing such sounds are highly remarkable We thus gain a high idea of their importance for sexual purposes and are reminded of the conclusion arrived at as to insects It is not difficult to imagine the steps by which the notes of a bird primarily used as a mere call or for some other purpose might have been improved into a melodious love one In the case of the modified feathers, by nor dur then ... females were led to select the best performers, the males which possessed the strongest or thickest or most attenuated feathers situated on any part of the body would be the most successful and thus by slow degrees the feath ers might be modified to almost any extent The females of course would not notice each slight successive alteration in shape but only the sounds thus produced It is a curious fact that in the same class of animals, sounds so different as the drumming of the snipe s tail, the tapping of the woodpecker s beak, the harsh trumpet like cry of certain water fowl, the cooing of the turtle-dove and the song of

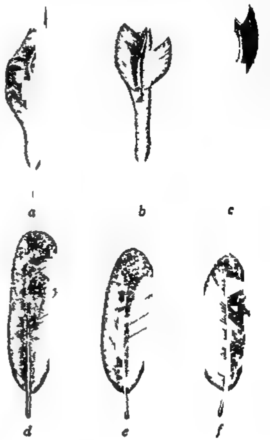


FIG 45 Second ry ng feathers f P pra

a d d fifth seco dary w g f tt r o l d f m le upp r surf c b d e th second ry ppe rf ce a d f s ve th co d ry l urf ce

the nightingale should all be pleas ng to the females of the several species But we must not judge of the tastes of di tinct pecies by a uni form stan lard nor must we ju lge by the stan lard of man s taste Even with man we should rem mber what discordant oises, the beating of tom toms and the shrill notes of

Sa

p 90 a d n *Ibis* ... in *Ibis* 1860 p 37

reeds, please the ars of savages. Sir S. Baker remarks, that as th stomach of the Arab prefers the raw m at and reeking h er taken hot from the animal, so does his ar prefe his equally coarse and discordant music to all other

Love Antics and Dances —Th curious love gestures of some birds ha e already been incidentally noticed so that little need h re be added. In N rthern America larg numbers of

we ha seen with th black African w a er instead of on the ground During th spri g our little wh te-throat (*Sylvia cinerea*) often r n the air abo some

courting the f male as has been Wolf An allied Indian bustard (*Otis bengalen*

FIG. 46 Bower-bird, *Chl mydera maculata*, with bower (from Brehm).

grouse th *Tetrao phan nellus* meet ery morning during th breeding seaso on a selected le l spot, and h re th y run round and round in circl of about filtee twenty feet in diamete so that th ground is worn q t bare like fairy ring. In these partridge-dances, as the are called by th hunters, th birds assum the strangest attitudes, and run round, some to th left and some to th ri ht. Audubon describes the males of h ro (*Ardea herodias*) as walking about n their long legs with great dignity bef re th f males, bidding defiance to their rivals. W th on f th disgusting carrion-vult res (*Cathartes jot*) th same naturalist states that the gesticulations and parade of th males t th beginnin of the lo e-seaso are xtrem l ludicrous." C rtain birds perform their lo e-antics th wing, as

sis) t uch times "rises perpendicularly into th air with a hurried flapping of his wings, raising his crest and puffing t th feath rs of his neck and breast, and then drops to the ground h repeats this manœuvre se eral times, t th sam tim humming in a peculiar ton Such f males as happen to be near "obey this saltatory summ ns, and when they pproach he trails his wings and spreads his tail lik tu key-cock."[19]

B t th most curious case is aff rded by three allied g n ra of Australian birds, th

The Nile Tributaries of Abyssinia, 1867 p. 203.

[19] For *Tetrao phasianellus*, see Richardson, *F una, Bor Americana*, p. 361 and for further particulars Capt. Blakiston, *Ibis*, 1863, p. 125. For the Cathartes nd Ardea, Audubon, *Ornithological Biography* vol. ii., p. 51 nd vol. iii., p. 89. O th white-throat, M cgillivray *History of British Birds*, vol. ii., p. 354. O the Indian bustard, Jerdon, *Birds of India*, vol. iii., p. 618.

famous bower birds —no doubt the co-descendants of some ancient pecies which first acquired the strange instinct of constructing bowers for performing their love antics The bowers (fig 46) which ᵊ shall hereafter

s shells bones

ind for the sole

of their nests are formed in trees Both sexes assist in the erection of the bowers but the male is the principal workman So strong is this instinct that it is practised under confinement and Mr Strange has described [9] the habits of some satin bower birds which he kept in an aviary in New South Wales At times the male will chase the female all over the aviary then go to the bower pick up a gay feather or a large leaf utter a curious kind of note set all his feathers erect, run round the bower and become so excited that his eyes appear ready to start from his head he continues opening first one wing then the other uttering a low whistling note and like the domestic cock seems to be picking up omething from the ground until at last the female goes gently towards him Captain Stokes has described the habits and play houses of another species the great bower bird which was een ᵊm

in its mouth These curious creations formed solely as halls of assemblage where both sexes amuse them elves and pay their court must cost the birds much labor The bower for instance of the fawn breasted species is nearly four feet in length eighteen inches in height and is raised on a thick platform of sticks

Decoration —I will first discuss the cases in which the males are ornamented either exclusively or in a much higher degree than the females and in a succeeding chapter those in which both sexes are equally ornamented and finally the rare cases in which the female is somewhat more brightly coloured than the male As with the artificial ornaments used by savage and civili ed men so with the natural ornaments of birds the head is the chief eat of decoration [1] The ornaments, as mentioned at the commencement of this chapter are wonderfully diversified The plumes on the front or back of the head consist of variou ly shaped feathers sometimes capable of erection or expansion by which their beautiful colours are fully displayed Elegant ear tufts (see fig 39 *ante*) are occasionally present The head is sometimes covered with velvety down, as with the pheasant or is naked and vividly coloured The throat also is sometimes ornamented with a beard wattles or caruncles. Such appendages are generally brightly-coloured and no doubt serve as ornaments, though not always ornamental in our eyes for whilst the male is in the act of courting the female they often swell and assume vivid tints, as in the male turkey ᴬᵗ ¹

o ɪ ɪɥɔt on the throat and into two horns one on each si le of ˡ lendi l top-

of the most

held [n] The

us) inflates

s neck and

with its wings drooping and tail expanded makes quite a grand appearance [n] Even the iris of the eye is sometimes more br ghtly coloured in the male than in the female and this is frequently the case with the beak for instance in our common blackbird *In Buceros corr gatus* the whole beak and immense ca que are coloured more con picuously in the male than in the female and the oblique grooves upon the sides of the lower mandible are peculiar to the male sex [64]

The head again often supports fleshy appendages filaments and solid protuberances. These if not common to both sexes are always confined to the males. The solid protuberances have been described in detail by Dr W Marshall [a] who sl ews that they are formed either of cancellated bone coated with skin or of dermal and other tissues With mammals true horns are always supported on the frontal bones but with birds various bones have been modified for this purpose and

gradations connecting these two extremes Hence as Dr Marshall ju tly re-

[9]Gould *H ndbook to the B d f Au t al* L i pp 444 449 455 The bow r f th ti l b rd m y be een n the Zool g c l Soc ty G r d ns, R ge t I a k.

See rema ks t this effect on th *Feel g of Beauty m g A m ls*, by Mr J Shaw in the *4th na m No* f 1866 p 681

See Dr Mar eco t w th col ed figures in *P oc d g Zool g al Society* 18 2, p 730

Mr M t ro *Ib* s L 1862 p 339

La l III I 1869 p 217

Libe d Sel ad II ck r *Nederländ. A h f Zoolog* B i, H ft 2, 18 2.

earls, variations of the most different kinds a e served f th d lopm nt thro gh se ual selection of these ornam ntal ppe da_ges. Elongated feath rs o pl m pring from almost every part of th body Th f ath rs n the throat and breast are som times d l ped into beautiful ruff and collars. The tail f ath ers are freq entl increased in length as w

F G. 47 *Paradis papuana* (T W Wood)

see in th tail-co rts f th peacock, and in the tail tself f th Argus ph asant. W th th peacock th bo of th ta l h been modified to support th l n tail-co rts.[60] Th bod of th Argus not larg than th t of f l y t th length from th nd f th beak t th tremity of th tail is n less than fi e feet three inches,[61] and th l of the beautifull ocellated seco dary wing f athers n arly three feet. In a small African night jar (*C u meiornis exillarius*) one of the primary w g feathers, during th breeding season, ttau a l ngth of tw nty six nches, whil t the l rd itself is only ten inches in length. In an th cl sely allied genus of night jars, th shafts of the lo_ated wing feathers are naked cept at the trem t where th re is a disc.[62] Again, in anoth r g nus of ht jars, the tail feath rs are n till more prod d usl de loped. In g n ral th f th rs f th tail are more often lo ted than those f th wings, a an great lo gation of th l tt impedes fl ght. We thus ee that in losely allied b rds rnaments of the sam kind ha e been gained by th males through the developm nt of w d ly diff rent feath rs.

It is a curious fact that the feath rs f species belo g to v ry distin t gro ps ha been modified in almost exactl the sam peculiar mann r Thu the wing f athers in one f th abo m nt oned ni ht jars are bare along the shaft, and t minat in disc o are, as th are som times called poo rack t shaped F athers f this kind occ in th tail f a mot m t (*F m m ta supercil aris*) of kin fish r finch, hum ming-bird, parrot, se ral In dian drongos (D crurus and Ed l s, in on of whi h th disc tand rtically) and in th tail f certain birds of par adise In these latte birds, sim lar f thers, bea tifully ocel lated rnament th head as is likew se th case with som gal linaceous birds. In an Indian bustard (*Syp eo tid rtus*) th feath rs f rming th ar tufts, which are about f ur inches in l ngth also terminate in discs.[63] It is a most singular

D W Marshall, Uber d V g lschwanz, ibid., B Heft 2, 18 2.

[61] Jardine Naturalist Libr ry Birds, vol. xi p. 166

[62] Sclater in the *Ibis*, vol. vi., 1864, p. 114 Living tone, *Expedition to the Zambesi* 1865 p. 66

[63] Jerd n, *Birds f India*, ol iii p. 620

fact that the motmots as Mr Salvin has clearly shown [10] give to their tail feathers the racket shape by biting off the barbs and further that this continued mutilation has produced a certain amount of inherited effect

Again the barbs of the feathers in various widely-distinct birds are filamentous or plumose as with some herons ibises birds of paradise and Gallinaceæ In other cases the barbs disappear leaving the shafts bare from end to end and these in the tail of the *Paradisea apoda* attain a length of [illegible]

dress comes to be admired by man so with birds a change of almost any kind in the structure or colouring of the feathers in the male appears to have been admired by the female The fact of the feathers in widely distinct groups having been modified in an analogous manner no doubt depends primarily on all the feathers having nearly the same structure and manner of development and consequently tending to vary in the same manner We often see a tendency to analogous variability in the plumage of our domestic breeds belonging to distinct species Thus top-knots have appeared in several species In an extinct variety of the turkey the top-knot consisted of bare quills surmounted with plumes of down so that they somewhat resembled the racket[illegible]ped feathers above described In certain breeds of the pigeon and fowl the feathers are plumose with some tendency in the shafts to be naked In

Fig 48 *Loph[illegible]* [illegible] male and female (from Brehm)

[10] *Proceedings Zoological Society* 18[illegible]3 p [illegible]

[11] Wallace in *Annals and Mag of Nat Hist* vol xx 1857 p 416 and in his *Malay Archipelago* vol ii 1869 p 390

Fig. 49 *Spathura underwoodi*, male and female (from Brehm).

the Sebastopol goose the scapular feathers are greatly elongated, curled, or even spirally twisted, with the margins plumose.[72]

In regard to colour hardly anything need here be said, for every one knows how splendid are the tints of many birds, and how harmoniously they are combined. The colours are often metallic and iridescent. Circular spots are sometimes surrounded by one or more differently shaded zones, and are thus converted into ocelli. Nor need much be said on the wonderful difference between the sexes of many birds. The common peacock offers a striking instance. Female birds of paradise are obscurely coloured and destitute of all ornaments, whilst the males are probably the most highly decorated of all birds, and in so many different ways that they must be seen to be appreciated. The elongated and golden-orange plumes which spring from beneath the wings of the *Paradisea apoda*, when vertically erected and made to vibrate, are described as forming a sort of halo, in the centre of which the head "looks like a little emerald sun with its rays formed by the two plumes."[73] In another most beautiful species the head is bald, "and of a rich cobalt blue, crossed by several lines of black velvety feathers."[74]

Male humming-birds (figs. 48 and 49) almost vie with birds of paradise in their beauty

[72] See my work on *The Variation of Animals and Plants under Domestication*, vol. i, pp. 282, 293.

[73] Quoted from M. de Lafresnaye in *Annals and Mag. of Nat. History*, vol. xiii, 1854, p. 157: see also Mr. Wallace's much fuller account in vol. xx, 1857, p. 412, and in his *The Malay Archipelago*.

[74] Wallace, *The Malay Archipelago*, vol. ii, 1869, p. 405.

fact that the motmots as Mr Salvin has clearly shown [72] give to their tail feathers the racket shape by biting off the barbs and further that this continued mutilation has produced a certain amount of inherited effect.

Again the barbs of the feathers in various widely-distinct birds are filamentous or plumose as with some herons ibises birds of paradise and Gallinaceæ In other cases the barbs disappear leaving the shafts bare from end to end and these in the tail of the *Paradisea apoda* attain a length of thirty four inches [73] in *P. Papuana* (fig 47) they are much shorter and thin Smaller feathers when thus denuded appear like bristles, as on the breast of the turkey-cock As any fleeting fashion in dress comes to be admired by man so with birds a change of almost any kind in the structure or colouring of the feathers in the male appears to have been admired by the female The fact of the feath

i ... nearly the same structure and manner of development and consequently tending to vary in the same manner We often see a tendency to analogous variability in the plumage of our domestic breeds belonging to distinct species Thus top-knots have appeared in several species In an extinct variety of the turkey the top knot con ... quills ... t they ... feath ... of the ... with ... t no ... in the shafts to be n ... ked In

Fig 48 *Loph ... o ... t* male ... f male (f... m Brehm)

72 P... d... g Zoolog... al Soc... ty 1873 p 429
73 Wall... ce in A... nals and Magazine of Nat... al History vol xx 1857 p 416 and in his Mal... y Archipelago vol ii 1869 p 390

to th m and t may p rl ps be attr buted to th d t a t o f tl e d fferent co liti ns to h cl the b rd n e p sed during the t o seaso s. Tl nlly the e m m otl er b ds tl e se s f wh ch are l ke b t wl cl are d l d ffe t n the r n r nd winter pl m g F rthly tl ere a l ird tl e sex s f luch d ff f m ach th r i col ur b t th f mal s, th gh mo lti g t ce re tai the same c lo s thr ugl ut the y a hilst the mal s u de g l a ge f col u som tim s g t on as with t n bus-tard faithly d l stly tl e e a bird tl e se f h h d ff r f m h tl e n b tl th r s mm and w t pl m g b t tle m l d goe a g t r m u t f cl ng t ach ce t easo tl tl f l — f l h th ruff (*Mach t s p g*) ff rs a good tan

W th p ct to th e e p rpo f tl e d ff e cs l r b tw tl u r d t pl m g th s m y i m ta as th th pta ga rs d g b tl as p t t W I n tl d ff ce b t tl e t pl g l gl t t y i r hap l tt b ted lready m ked to the d rect act f th co d t s f l f B t w th m l d tl a h rdly b a d bt

tak s of tl e nature f tl e ex lu ively masculi e plum ge of many otl er birds

Fr m tl e foreg ng facts more especially f m n tl er s x f ce ta n birds chang ng col ou d t g e tl er a r r u l m lt or chang g so sligl tly tl t tl e cl nge ca hardly be of any if the f males of tl r
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assume m rnamental l arac u b eed ng seaso but th t tl double m o lt hav ng been ig nally acquired f r some dis-ti t purpose has s bsequently b en tak n l t g of in certain cases for gain g a l t l plumage

It ppears at f r t igl t a surp ing circum t e tl t some closely allied speci s sl uld r g l ly u de go a d ble annual m ult, and tl ers ly ngle The ptarmig n fo t ce m lts tw ce r e en thrice n tl e nd tl l lackcock ly nce som f tl pl n l lly col edl y ck rs (Nectar n) f l d l some s b g n ra f obscu ely col ed p l ts (A tl u) l av a l bl l l t l nel a n al mo lt. But
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tl e ern l m lt f from compl t so f atl l g e ed and som cl anged n col u Tl lso eason t b h e tl t w tl ce t b ta ds nd l l k b rds, wh h p pe ly d g a do bl ult, som of th lde nal t n tl i ptu l plumage th gl t tl e y A f l ghly mod f ed f the m y n ely b added d r g tl e p g to the plum g a occurs tl the d sc f m d ta l f atl f tain dro g (Bhrng) n I d a, l th the lo g t d f tl tl back neck d c est f ce ta n l By l t ps as th se the vern l

also kn n tl t fi t by ff t g tl r prod t y t m f m l b ds, f q tlv

f d by M B tl tt th t gl t m pec m f th kn t (*Fri g t*) t d tl ad ed te pl m g the Zool g l G rd th o gh t th y f m l h fact y nf th t th nm pl m g tl gl mm t both se

pe ed th l rd k t ff g tly f m b d f p y bef re t h acq red ts mm dress see W lh lm W ght, Ll y d G m *B d f S d* 1867 p 12.

435 d 444 d M St ff d All th *Ibis* l. 1863 p 33

O th m lt g f th pta m g see C ld *B d fG tB it n.* O th h y L J d *B ds f India,* l. pp 359 365 369 O th m ult g of A thus se Blyth, in *Ibis* 1867 p 32

as every one will admit who has seen Mr Gould's splendid volume h collec ly differ Almost or their plumage has been taken advantage of and modified and the modifications have been carried as Mr Gould shewed me to a wonderful extreme in some species belonging to nearly every sub group Such cases are curiously like those which we see in our fancy breeds reared by man for the sake of ornament certain individuals originally varied in one character and other individuals of the same species in other characters and these have been seized and much f the fan the beak The sole between thes in the st of e more beautiful males

I will mention only one other bird remarkable from the extreme contrast in colour between the sexes namely the famous bell bird (*Chasmorhynchus niveus*) of S America, the note of which can be distinguished at the distance of nearly three miles and astonishes every one when first hearing it The male is pure white whilst the female is dusky green and white is a very rare colour in terrestrial species of moderate size and inoffensive habits The male also as described by Waterton has a spiral tube nearly three inches in length which rises from the base of the beak It is jet black dotted over with minute downy feathers This tube can be inflated with air through a communication with the palate and when not inflated hangs down on one side The genus consists of four species the males of which are very distinct whilst the females as described by Mr Sclater in a very interesting paper closely resemble each other thus offering an excellent instance of the co t

white with the exception of a large space of naked skin on the throat and round the eyes, which during the breeding season is of a fine green colour In a third species (*C tricarunculatus*) the head and neck alone of the male are white, the rest of the body being chestnut brown, and the male of this species is provided with three filamentous projections half as long as the body—one rising from the base of the beak and the two others from the corners of the mouth [5]

The coloured plumage and certain other ornaments of the adult males are either retained for life or are periodically renewed during the summer and breeding season. At this same season the beak and naked skin about the head frequently change colour as with some herons, ibises, gulls one of the bell birds just noticed &c. In the white ibis, the cheeks the inflatable skin of the throat and the basal portion of the beak then become crimson [6] In one of the rails, *Gallicrex cristatus* a large red caruncle is developed during this period on the head of the male So it is with a thin horny crest on the beak of one of the pelicans *P erythrorhynchus* for after the breeding season these horny crests are shed like horns from the heads of stags and the shore of an island in a lake in Nevada was found covered with these curious exuviæ [7]

Changes of col

margins being periodically shed or on these three processes more or less combined The shedding of the deciduary margins may be compared with the shedding of their down by very young birds for the down in most cases arises from the summits of the first true feathers [8]

With respect to the birds which annually undergo a double moult there are first some kinds for instance snipes swallow plovers (Glareolæ) and curlews in which the two sexes resemble each other and do not change colour at any season I do not know whether the winter plumage is thicker and warmer than the summer plumage but warmth seems the most probable end attained of a double moult where there is no change of colour Secondly there are birds for instance certain species of Totanus and other Grallatores the sexes of which resemble each other but in which the summer and winter plumage differ slightly in colour The difference however in these cases is so small that it can hardly be an advantage

M Sclat *Intell ct al Ob rver* J 1867 B al B nd p 118 See also M t re t g paper th plat in th *Ibis* 1863 p 90
[6] *Land d W t* 1867 p 394
[7] M D C Ell t *Proc Zool Soc* 1869 p 59
Nitzsch It yl l ed ted by P L Sclat R y Society 186 p 14

to them and t may perh ps, be attrib ted to the direct acti n of th different co d ti ns in which th b rd are xposed during the two seasons. Thirdly th re are man otl e birds th sexes f hich are alike b t which are wid l diff re t in th ir umm and winte pluma e. F rthly th re are b rds th sexes of hich diff from each the in col ur b t the f males, thou h m ulting twice, retain the same colours thro gh t th ar hilst the males und rgo a chang f col som times gre t as with certain bustards. Fifthly and lastly th re are b rds th sexes of which diff from each th r in both their umm and wint pl m b t th male ndergoes a great am unt of change t each recurre t season than th f mal — of hich the ruff (Machete p g ax) ff rs a good instance

W th respect to th cause r purpose f th differences in colour between th mme and winte pluma e, this may in som inst ces, as with th ptarmigan, serv d ri g both seaso protection. Wh n th diff rence

that th umm plumag is rnam ntal, n whe both se es are alil W m co l d that this is th ase with many h rons, grets, &c., for th acq re th ir bea tiful plum nly d ring th breeding season. M reo such pl mes, top-kn ts, &c., th gh possessed by both se es, are occasi nally littl m re de loped in th mal than in th f mal and th resembl th plumes and rnam ts possessed b th males alon f ther birds. It is also kno n that confin m t, by affecting th reproducti tem f mal birds, freq ntl checks th d lopm t f th ir seco dary sexual charact rs, b t has n mmedi t in fl nce an th haract rs and I am f rmed b M Bartlett that ei ht nme specim ns of th kn t (Tri g ca utus) retained thei unad rned winte plumag in th Zoological Gard ns thro gh t th ear from which fact w ma nf that th umm pl mag tho gh comm n to both se es, par tak s of the nature of th e lusively masculine pl

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slightly that the chang can hardly be service to them, and from th femal s f othe peci s moulting twice y t retaining the same col urs thro gh ut the y ar w may conclude th t th hab t f annuall moulting twice has n t been acquired rd r that the male h uld assume an ornam ntal character during the breedi g season b t that the d ubl m lt, ha ing been originally acquired for some distinct purpose has ubseq tly been taken ad antage f in certain cases for gaini g a n ptial pl mag

It ppears at first sight a surprising circum tance that som losely allied pecies hould regularly und rgo a d ubl annual moult, and

Th ptarmigan, for

of India and som sub-g nera of obscurely col ed p p ts (Anthus) ha a do ble wl lst oth rs h nl a si gle annual m ult. But th grad t th manne of m ult g which are kn wn to occu w th various birds, sh w us h w pecies, r whol gro ps, might ha e riginally acquired their doubl ann al mo lt, ha ing o ce gai ed the hab t, h e gain lost t. W th certain bustard and plo rs the rnal mo lt is far from compl te, some feath rs being en wed and som changed n colour Th re also reason to belie that with certai bustards and rail lik birds, which prope ly und rgo a d bl m ult, some of th old r males retain thei ptial plumag thro gh t th year A f w highly modified f th rs may m rely be added duri g the pring to th pl mag as occurs with the disc f rmed tail feath rs of certain dro gos (Bhri) in India, and w th th lo gated feath rs n th back, neck, and crest f certain h rons. By ch tep as these, th rnal

The brown mottled summer plumag of th ptarmigan is of as much importa ce t t as protection, as the hite te plumag for in Sca dina ia duri g the p g he the now has disappeared, this b rd is kn w t uffer greatly from b rds of prey before t has acquired ts ummer dress see Wilhelm vo W ht, Lloyd, G me B rds of S den, 1867 p. 125.

In regard to the previous stat me ts moulting see, nipes, &c., Macgilli ray Hist Brit. B ds, I p 3 1 Glareolæ curlews, nd bustards, Jerdon, B ds of India ol iii, pp 615 630 683 on T ta us, ibid., p. 00 n the plumes of herons, ibid p 738, d M cgilli ray ol. pp. 435 and 444 and M Staff rd Allen, in th Ibis l 1863, p. 33

On th moulti g f th ptarmigan, see Gould B ds of G at B itain. O the h ey-suck rs, J rd Birds of India, ol i, pp. 359 365 369 O th m ulting of Anthus, see Blyth, in Ibis 1867 p 32.

moult might be rendered more and more com plete until a perfect double moult was acquired Some of the birds of paradise retain their nuptial feathers throughout the year and thus have only a single moult others cast them directly after the breeding season and thus have a double moult and others again cast them at this season during the first year but not afterwards so that these latter species are intermediate in their manner of moulting There is also a great difference with many birds in the length of time during which the two annual plumages are retained so that the one might come to be retained for the whole year and the other completely lost Thus in the pring *Machetes pugnax* retains his ruff for barely two months In Natal the male widow bird (*Chera progne*) acquires his fine plumage and long tail feathers in December or January and lo es them in March so that they are retained only for about three months Most species which undergo a double moult keep their ornamental feathers for about six months The male however of the wild *Gallus bankiva* retains his neck hackles for nine or ten months and when these are cast off the underlying black feathers on the neck are fully exposed to view But with the domesticated de cendant of this species the neck hackles of the male are immediately replaced by new ones so that we here see as to part of the plumage a double moult changed under domestication into a single moult [5]

The common drake (*Anas boschas*) after the breeding eason is well known to lo e his male plumage for a period of three months during which time he assumes that of the female The male pin tail duck (*Anas acuta*) loses his plum age for the shorter period of six weeks or two will be far from feeling surprise at fin ling gra dations of all kinds If the male pin tail were to ac quire his new plumage within a still shorter period the new male feathers would almost necessarily be mingled with the old and both with some proper to the female and this apparently is the case with the male of a not distantly allied bird namely the *Mergan ser serrator* for the males are said to undergo a change of plumage which assimilates them in ome measure to the female By a little further acceleration in the process the double moult would be completely lost [8]

Some male birds as before stated become more brightly coloured in the spring, not by a vernal moult but either by an actual change of colour in the feathers or by their obscurely coloured deciduary margins being shed Changes of colour thus caused may last for a longer or shorter time In the *Pelecanus onocrotalus* a beautiful rosy tint, with lemon-col oured marks on the breast, overspreads the whole plumage in the spring but these tints, as Mr Sclater states do not last long, disappearing generally in about six weeks or two months after they have been attained Certain finches shed the margins of their feathers in the spring and then become brighter col oured while other finches undergo no such change Thus the *Fringilla tristis* of the United States (as well as many other American spe cies) exhibits its bright colours only when the winter is past whilst our goldfinch which ex actly represents this bird in habits and our siskin which represents it still more closely in structure undergo no such annual change But a difference of this kind in the plumage of allied pecies is not surprising for with the comm n linnet which belongs to the same family the crimson forehead and breast are di played only during the ummer in England whilst in Madeira these colours are retained throughout the year [84]

Display by Male Birds of their Plumage — Ornaments of all kinds wh ther permanently or temporarily gained are sedulously dis played by the mal s and apparently serve to

defance to all human reasoning But the believer in the gradual modification of pecies

[8]F r th e f re g tal e t n r g rd to p rt l
lr l o old m l s ret g tl pt l

O th \ dua *Ibi* v L 15 p
Dro osl r kes, J rd *Ibid* l i p 435 On the
v al m lt f th *Herod* *b b lcus* Mr S S
All n n *Ibi* 1863 p 33 On *G llus ba ki va* Blyth
i *nals and Mag f Nat ral History* l i 1848,
p 45 e lso n th s subject my *V riat f*
A mals nder D e t c t n, v l i, p 236

[8]S e
l p 34
w th
Y rrell
[8]O l
1869 p
O ithol g al Biogr phy l i pp
J rd *B d f I id* l i 383 O th
F ngill cannab f M l ra, Mr E. V rno Har
court, *Ibis* v l v 1863 p 230

excite, attract, or fascinate the f males. B t th males will som times displa their orna ments, when not in the presence of the f males, as occasionally occurs with grouse at their balz-places, and as may be noticed with the peacock this latter bird, how ve evidently wishes for a spectato f some kind and as I ha often seen, will sh w ff his finery before poultry or n p gs.[31] All naturalists who have closely att nded to th hab ts f birds, hether in state f n ture or under confinement, are unanimously of pinion that the males tak d light in displaying th ir beauty

them to th greatest advantage bef re th female D Jerd n[32] insists that th bea tiful pl mage of th male serves to fascin te and ttract th f male M Bartl tt, t th Zoological G strongest

It mu India to com ... pea-fowl, the males displaying their gorgeous trains, and trutting about in all the pomp of pride before the gratified f males. The wild turkey-cock erects his gl ttering plumage ex pands his finely zoned tail and barred wing feathers, and altogeth r with his crimson and blu w ttles, makes s perb tho gh, to our e) grotesqu ppearance. Sim lar facts ha e already been g n with respect to grouse of various kinds. Turning to an oth Order The male *R picola crocea* (fig. 50) is one of the most beautiful birds in the world, being of a splendid or ange with some of th f athers curi usly truncated and plu mose Th female is brownisl green, shaded with red and has a much maller crest. Sir R Schomburgk has described tl courtship h f und one of their meeting places where ten males and two females were present. Th space was from f ur to fi e feet in diam ter and appeared to ha been cleared of ev ry blad f grass and smoothed as if by human hands. A male was capering, to the pparent delight of se eral thers. N w spreading ts wings, throwing p ts h ad, or pening ts ta l lik a fan now strutting about with a h pping gait until tired, wh n t gabbled som kind of n t and was reh ed by an the Thus three of th m uccessi ely took the field and then with self pprobation, withdrew to rest. The Indians, in rder to obtain their skins, wait at on f the meeting places till the birds are eag rly e gaged in dancing, and then are able to kill with th ir po so ed arrows f ur or fi males, o aft th th [33] W th birds f para dise d zen more full-plumaged males con gregate in tree to hold dancin party as t is called b th nati es and here th fly abo t, raise th wings, el t their exquisite pl m s, and make th m vibrat and th whole tree seems, as M Wallace remarks, t be filled with w ving plumes. When thus engaged they

F G. 50 *R picol crocea*, male (T W Wood).

[31] See also *Ornamental P ultry* by Rev E S. Dix n, 848, p. 8.

[32] *B ds f Ind* tral t ol. p xxiv th peacock, vol. m p. 507 See G uld *Int oduction to the Trochuidae* 1861 pp. 15 and 111.

[33] *Journal f R. Geogr ph. Soc.*, vol. x., 1840, p. 236

become so absorbed that a skilful archer may shoot nearly the whol se birds ay Archi a keeping t atners clean often spreading them out examining them and removing every speck of dirt One observer who kept several pairs alive did not doubt that the display of the male was intended to please the female [58]

The gold and Amherst pheasants during their courtship not only expand and raise their splendid frills but twist them as I have myself seen obliquely towards the female on whichever side she may be standing obviously in order that a large surface may be displayed before her [59] They likewise turn their beautiful tails and tail coverts a little towards the same side Mr Bartlett has observed a male Polyplectron (fig 51) in the act of courtship and has shown me a specimen stuffed in the attitude then assumed The tail and wing feathers of this bird are ornamented with beautiful ocelli like those on the peacock s train Now when the peacock displays himself he expands and erects his tail transversely to his body for he stands in front of the female and has to shew off at the same time his rich blue throat and breast But the breast of the Polyplectron is obscurely coloured and the ocelli are not confined to the tail feathers. Consequently the Polyplectron does not stand in front of the female but he erects and expands his tail feathers a little obliquely lowering the expanded wing on the same side and raising that on the opposite side In this attitude the ocelli over the whole body are exposed at the same time before the eyes of the admiring female in one grand bespangled expanse To whichever side she may turn the expanded wings and the obliquely held tail are turned towards her The male tragopan pheasant acts in nearly the same manner for he raises the feathers of the body though not the wing itself on the side which

FIG 51 *P lyplect h q* male (T W Wood)

is opposite to the female and which would oth rwise be concealed so that nearly all the beautifully spotted feathers are exhibited at the same time

The Argus pheasant affords a much more remarkable case The immensely developed secondary wing feathers are confined to the male and each is ornamented with a row of from twenty to twenty three ocelli, above an

[58] *Is nd Mag f Nat H t* vol xiii 1854 p 157 also Wallace *ibid* l x 1857 p 412 nd *Th Malay A h pel g* t 9 p 2.2 Also m *Illustrirt*

St dent April f d pl y pa se ph asa t *Ph ersicolor* and h calls it th lat ral ne-sided display

spots of ar blou... tiger and leopard combined. These beautif l ornam are hidd n til th mal sh ws himself ff bef re th f mal He th n erects hi tail, and expands his wing feathers into a great,

F G. 52 Sid view of male Argus ph asa t, whil t d playing bef re the f male Observed nd sk tched from ture by M T W Wood.

almost pright, circular fan sh ld wh ch is carried fro t f th body Th neck and h ad are h ld d so that th are co cealed b th fan b t th b rd m d to see th f mal bef re wh m h is displ ying himself som t mes pushes his h ad betwee tw of th lo wi g f tl rs (as Mr Bartl tt has seen) and th prese ts a grotesq ppear ance. This must be freq t hab t with the bird n a state of nature for Mr Bartl tt and his son on examini g some perfect kins sent from the East, found a place bet een two of th feathers which was much fr ed as if the head had here frequ ntly been pushed through. M Wood thinks that the male can also peep at the f male on o e side be ond the marg n f the fan

Th ocelli on the wi g f ath rs are wond rful objects fo the re so shaded that, as th Duke f Argyll remarks,[60] th y tand o t like balls l ng loosely within sockets. Wh n I looked at the pecim n in th Briti h Muse m which is m unted with tl wings ex panded and trail g d wn wards, I was howe r greatly disappointed f the ocelli ap pea ed fl t, or n conca e. But Mr Gould soon made the case lear to me, f he held the f ath rs rect, in the po ti n in wh h they w uld nat rally be displayed and n w from th ligt t sl ning on th m from abo each ocellus t ce re sembled th ornam nt called a ball and sock t. These f th rs h e been sh wn to se al art ts, and all ha e expressed th ir admirat at th perfect shading It m y w ll be asked, could ch artistically shaded rnam nts ha been f rmed by m ans f sex al select ? B t t will be con ni nt to d f ng an answe to this q est n until w tre t in th next ch pt f th principl f gradat n

Th f ing remarks late to th seco dary wing feathers, but th primary wing feath rs, which n mo gall aceous b rds are unif rmly colo red are in th Argus ph asa t equally w d rful. Th y are f soft brown tint with num rous dark pots, ach f which consi ts of two or three black d ts with rround g dark zo B t th chi f rnam t is a space parallel to the dark bl shaft, which in o tl f rms a perfect seco d feath lying within th tru feath This in part is col ured f a lighte

[60] *The Reig of Law* 1867 p 203

chestnut and is thickly dotted with minute white points I have shewn this feather to several persons and many have admired it even more than the ball and socket feathers and have declared that it was more like a work of art than of nature Now these feathers are quite hidden on all ordinary occasions but are fully displayed together with the long secondary feathers when they are all expanded together so as to form the great fan or shield

The case of the male Argus pheasant is eminently interesting because it affords good evidence that the most refined beauty may serve as a sexual charm and for no other purpose We must conclude that this is the case as the secondary and primary wing feathers are not at all displayed and the ball and socket ornaments are not exhibited in full perfection until the male assumes the attitude of courtship The Argus pheasant does not possess brilliant colours so that his success in love appears to depend on the great size of his plumes

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mals may deny that the female Argus pheasant can appreciate such refined beauty but he will then be compelled to admit that the extraordinary attitudes assumed by the male during the act of courtship by which the wonderful beauty of his plumage is fully displayed are purposeless and this is a conclusion which I for one will never admit

Although so many pheasants and allied gallinaceous birds carefully display their plumage before the females it is remarkable as Mr

wallichii) so that these birds seem conscious that they have little beauty to display Mr Bartlett has never seen the males of either of these

not

the Cheer as

Weir also finds that all male birds with rich or strongly-characterised plumage are more quarrelsome than the dull-coloured species belonging to the same groups The goldfinch for instance is far more pugnacious than the linnet, and the blackbird than the thrush

Those birds which undergo a seasonal change of plumage likewise become much more pugnacious at the period when they are most gaily ornamented No doubt the males of some obscurely-coloured birds fight desperately together but it appears that when sexual selection has been highly influential and has given bright colours to the males of any species it has also very often given a strong tendency to pugnacity We shall meet with nearly analogous cases when we treat of mammals On the other hand with birds the power of song and brilliant colours have rarely been both acquired by the males of the same species but in this case the advantage gained would have been the same namely success in charming the female Nevertheless it must be owned that the males of several brilliantly coloured birds have had their feathers specially modified for the sake of producing instrumental music though the beauty of this cannot be compared at least according to our taste with that of the vocal music of many songsters

We will now turn to male birds which are not ornamented in any high degree but which nevertheless display during their courtship whatever attractions they may possess These cases are in some respects more curious than the foregoing and have been but little noticed I owe the following facts to Mr Weir who has long k

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of the female and then puffs out his breast so that many more of the crimson feathers are seen at once than otherwise would be the case At the same time he twists and bows his black

to le in a ludicrous manner

bell as the

the same time b ing slightly expanded with the pure white bands on the shoulders thus render I con picu s The common linnet distends hi ro y r ast lightly expands his brow ings an l tail so as to make the best of them by exhibiting th ir white edgings We must howe er be cautious in concluding that

s r read out solely for display as

same time scraped on th gro nd The male goldfinch beha es differently from all other finches his wings are beautiful, the sh ulders being black, with th dark tipped wing feathers spotted w th white and edged with golden yelow When he courts the f male he sways his body from id to side and quickly turns his sughtl expanded wings first to one side, then to the oth with a g lden flashing effect. Mr Weir inf rms m that no th British finch turns thus from sid to sid during his courtship, not ev n the closel -allied male siskin, for h would not thus add to his beauty

Most of the British buntings are plain col oured birds b t in th spring th feathers on the head of th mal reed-bunting (*Emberiza schœniculus*) acquire a fin black colour by the abrasion of th dusky tips and these are erected during the act of courtship. M Weir has kept tw pecies of Amadina from Australia the *A. castanotis* is a ry small and chastely coloured finch, with dark tail, whit rump, and j t-black pper tail-co erts, each of the latter being marked with three large conspicuous val pots of white. This species, he courting th f mal slightly spreads out and ibrates these parti-coloured tail-co rts very pecul ar manner Th mal

colour and these, t might be thought could ne er be well exhib ted b t th bird when excited often spreads th m out laterall so that the can be see en from abo e. The crimson und tail-co rts of som th birds as with of th woodpeck rs, *P cus major* can be see without any such display The common pigeo has iridescent feathers on the breast, and ery ne must ha seen how the male inflates his breast whil t courting th f male, thus shewing them off to th best ad antage O of th beautiful bronze-winged pigeons of Australia *Ocyphaps lophote*) behaves, as escribed to m b M Weir very differentl th male whilst standing bef re the f male low rs hi head almost to th ground spread out and raises his tail, and half expands his wings. H th n alternat ly and slowl aises and depresses his body so that the rid scent m tallic feathers are all seen at once and glitte in the sun.

Sufficient facts ha now been gi en to sh w with what care male b rds display their various charms, and thus th y do w th th utmost skill. Whil t preening their f thers, the ha e frequent opportunit es f r admiring them sel es, and of tud ing how best to xhibit th ir beauty But as all the males of th same species display th msel es in xactl the same manne t ppears that actions, at first perhaps intentional, ha e become instincti e If so, we ought not to accuse birds of conscious anit yet wh n we see a peacock trutt about, with expanded and quivering tail feathers, he seems th y ry emblem of prid and vanity

Th arious ornaments possessed by th males are certainl of the highest importance to th m, f r in some ases th y ha e been acquired at th expe se of gre tl impeded pow rs of fl ght or of running. The African night jar (Cosm tornis) which during th pairing season has on of ts primary wing-feathers dev loped into a tream r of ry great l ngth, is th reby m ch retarded in ts flight, althoug t oth times remarkable f r ts swiftness. Th nwi ldy size of th secondary w feath rs of th male Argus pheasant i sa l almo t entirel to d pri th bird of flight. Th fi plumes f mal b rds of paradise t t

ably do not suff mu h nco eni nce in searching for food from th ir impeded powers of mo em t b t th re can hardl be a doubt that th must be m ch more liable to be struck down b birds of prey N can w d ubt that th long train of th peacock and th lo g tail and wi -feathers of th Argus ph asant mu t rend th m an easi pre to an prowling tige -cat than would otherwise be the case. E en th bright colours of many mal birds cannot fail t mak them con picu us t th ir nemies of all kinds. Hence as M Gould has remarked, t probably is that uch birds are generall of sh disposition, as if conscious that their be uty was a source of danger and are much more difficult to discover o pproach, than th sombre coloured

For the descriptio of these birds, see Gould' *Handbook of the Birds of Australia*, vol. ii., 1865, p. 41

Birds of India, ol. ii., p. 96.

and comparatively tame females or than the young and as yet unadorned males[53]

It is a more curious fact that the males of some birds which are provided with special weapons for battle and which in a state of nature are so pugnacious that they often kill each other suffer from possessing certain ornaments Cock fighters trim the hackles and cut off the combs an l gill ... l the ... ibbed ... arful ... easy ... rsary s beak and as a cock always strikes where he holds when once he has seized his foe he has him entirely in his power Even supposing that the bird is not killed the loss of blood suffered by an undubbed cock is much greater than that sustained by one that has been trimmed[54] Young turkey-cocks in fighting always seize hol ...

... jected ... and wattles are not ornamental and cannot be of service to the birds in this way but even to our eyes the beauty of the glossy black Spanish cock is much enhanced by his white face and crimson comb and no one who has ever seen the plendid blue wattles of the male tragopan phea ant disten led in courtship can for a moment doubt that beauty is the object gained From the foregoing facts we clearly see that the plumes and other ornaments of the males must be of the highest importance to them and we further see that beauty is even sometimes more important than success in battle

[53] On the Cosmetorn see Livingstone *Expedition to the Zambesi* ... phens ... p 167 ... rel m ... Br ... vol ... Gould on the ... hyn s of m le bird *Handbook to Birds of Austra ha* vol i 1865 pp 210 1 7

[54] Tegetmeier *The Poultry Book* 1866 p 139

CHAPTER XIV

BIRDS—*C nt n ed*

When th sexes diff r in bea ty n th power of singing, n prod cing wl at I h called instrum tal mus it is alm t n ri abl th mal wh urpasses tl f male Tl se q alities, as w h ve j t seen, re ul tlv of t th mal When th y are

tions, and oft perf rms t ang nt s ground n th air th presence f th fe

ttract in choice, and pref certain males Thus l tte que tio can be answ red in th affirm ti by much direct and direct d ce It is far more difficult to decid what qualities d t min th cho ce of th f males but h re gain w ha som direct and d rect d nce th t t is to larg xt nt th t rnal ttracti ns of the mal th gh d bt h g ur cour ag and th m tal q al t s com nt play W will begin tl th ind rect d ce

at t f pa g Thus in G rmany and Scandi

n m re t ird co greg t t th l ks and the sam place ft freq ted d n g cessi ars Tl l k of th capercailzi last from th end f March t th middl n nd of M In N rth Am ri tridg dance of th *T t a phas nell* la t f mo th more Oth kind f g se both in N rth Am ri and East rn S beria, f ll w

n a ly the same hab ts. The fowl rs d scover the h llocks wh re tl ruffs co gregat by th grass be ng trampled bare and thi hews tl at tl e sam pot is l g frequ nted Th Ind ans f Gu ana are well acq ainted w th the cl ared are as, where th y xpect to find th bea tiful cocks of the rock and the n ti e of New G in a kn w the trees where from ten to tw nty mal b rds of paradise in full plum g congreg t In this l tt r case it is n t ex pressl t ted that the f mal s meet n tl e sam trees, but the hunte s, if n t speciall asked w uld probably n t m nt n tl r pres ce, as th r skins are l ss. Small part of an African we (Ploceu) co gat d ring tl breed g season and perform f l urs th r graceful oluti ns. La g num l pe (*Scolopax m j*) as

running abo t like so many ats, puff tl f th rs, fl pping th ir wings, and utte ing th trang t s.

Som f th abo birds,—th black-cock, capercail ph asant grouse ruff solitary sn pe and pe h p others,—are as is bel e ed poly gamists. W th ch b rds t m ght ha been th ght th t th stro g mal s w ld simply ha dri n w y th w ake and th n t ce h tak n possess n f as many fe- m l as poss l l but if t be indispensabl fo tl mal t cit pl ase th f mal w can und rstand the l gth f th co rtship and the co greg ti f so many ind vid als f both se es t th sam pot C rtain strictly mo- n gamo pec es lik wise h ld n pt al assem bla es th seems t be th case in Scandina a

Nordman describes (*Bull. Soc. Imp. de Nat.* Moscou, 1861 tom. xxxi p. 264) th *balzen* of *Tet ogallus* in Amur La d. H estim ted th umbe f birds assembled t bo e hundred, t cou t g th f males, hich l h d the urround- g bu hes. Th ises ttered diff from those of *T ro ll*

1857 p. 412. the sn pe L yd, *ibid.* p

with one of the ptarmigans and their leks last from the middle of March to the middle of May In Australia the lyre bird (*Menura superba*) forms small round hillocks and the *M Alberti* scratches for itself shallow holes or as they are

y arge and an account has lately been published[3] by a traveller who heard in a valley beneath him thickly covered with scrub a din which completely aston ished him on crawling onwards he beheld to his amazement abo t

during the breeding sea son and here the males meet and contend with each other for the favours of the female and here the latter assemble and coquet with the males With two of the genera the same bower is resorted to during many years

The common magpie (*Corvus pica* Linn) as I have been informed by the Rev W Dar win Fox used to assemble from all parts of Delamere Forest in order to celebrate the great magpie marriage Some years ago these birds abounded in extraordinary num bers so that a gamekeeper killed in one morn ing nineteen males and a y n

at particular spots where they could be seen in flocks chattering sometimes fighting bustling and flying about the trees The whole affair was evidently considered by the birds as one of the highest importance Shortly after the meeting they all separated and were then observed by Mr Fox and others to be paired for the ng district in a large num of cour e b ave different

ason in different countries For instance I have heard of only one instance from Mr Wedderburn of a regul r

exc ed special names.

Unpaired Birds —From the fact n w giv n we may conclude that the courtship of birds belonging to widely different group is often a prolonged delicate and troublesome affai There is even reason to su pect improbable as this will at first appear that some males and females of the same pecies, inhabiting the same district do not always please each other and consequently do not pair Many accounts have been published of either the male or fe male of a pair having been shot and quickly replaced by another This has been observed more frequently with the magpie than with any other bird owing perhaps to its con picu ous appearance and ne t The illu trious Jen ner states that in Wiltshire one of a pair was daily shot no less than even times successively but all to no purpose for the remaining mag pie soon found another mate and the la t pair reared their young A new partner is generally found on the succeeding day but Mr Thompson gives the ca e of one being replaced on the evening of the ame day Even after the eggs are hatched if one of the old birds is destroyed a mate will often be found thus occurred after an interval of two days, in a case recently observed by one of Sir J Lub bock s keepers[4] The first and most obvious conjecture is that male magpies mu t be much more numerous than females and that in the above cases as w ll h

f gamekeepers in Delamere Fore t as sured Mr Fox that the magpies and carr n crows which they formerly killed in succe i n in large numbers near their nests, were all males and they accounted for this fact by the males being easily killed whilst bringing food to the sitting female Macgillivray how ver gives on the authority of an excellent ob server an instance of three magpies u ces sively killed on the same nest, which w re ll females and another case of six ma pies uc ce sively killed whilst sitting on the same eggs which renders it probabl that mo t of th m were f mal though as I hear from Mr Fox the male will sit on the eggs when the female i killed

Sir J Lubbock gameke per has repeatedly shot but how oft n he could not say one f a pair of jays (*Ga rulu gla darıu*) and has never failed lortly aft rw rds to find th

[3] Quoted by Mr T W Wood *The St d nt* April 18 p 125
[4] Gould *Handbook f th B d f* pp. 300 308 448 451 O th ptarmig n bo alluded to see Ll yd *Ibid* p 129

[4] ... *Philosophical T ac tions* 1824 p 21 M g ll *Hist Brit B d* ... *Nat Hist y* ... 1842 p 494

survivor re-matched. Mr Fox, Mr F Bond, and others have shot o of a pair of carri n-crows (Corvus corone) b t th nest was soon again tenanted by a pai These b rd are rather commo b t th peregrine-falcon (Falco peregri us) is rare, y t M Thompson states that in Ireland if th an old mal r female be killed in the breeding season (not an uncommon circumstance) anoth rmat isf und ithin erv f w d s, so that tl e rnes, n t withstanding such casualties, are sure to turn out their compleme t of ung M J nn r Weir has known th same thing with th peregrine-falcons t Beachy H ad. Th same observer informs me that three kestrels (Falco tinnunculus) all males, w re killed on aft r the other hilst ttending th sam ne t two of these were in mature plumage but the third as in the plumage of the pre ous year E n with the rare gold eagl (Aquila hry aëtos) Mr B kbec was assured by a trustw rthy gamekeeper in Scotland, that if on killed, anothe is soon f und. So with th whit wl (Strix flammea) the surv or readil f und a r pl t m sch f w t n.

th same d y Mr Engl heart also informs me that h used during se eral years to shoot one of a pair of starlings which built in a h le i a h use at Blackheath but tl e loss was alwa s immedi t ly repaired. Durin, on season he kept an account, and found that he had sh l thirty five birds from the same nest th se consisted of both males and females, b t in what proportion l could not say ne rth less, aft r all this destructi n, a brood was reared

These facts well deserve attention. H w s t that th re are b rds n gh ready to replace immediat ly lost mate of e th r sex Mag p es, j ys, carrion-crows, partridges, and some other birds, are alwa seen during the pring in pairs, and n e by th msel es and these offer t first sight the most perplexing cases. B t birds of th sam sex, alth ugh of co rse n t trul paired som t mes h e in pa rs o in small parti s, as is known to be th case w th p geons and partridges. Birds also som times li n triplets, as has been bserved with n r 1 t t

1 a

parro s, which n p ... of their nests, to be shot but th which as left, the t cock hen, presentl procured mat and so f se ral times f llowing. I could add analogous cases relating t th chaffinch, nightingale and redstart. W th respect to the latt bird (Phœnicura ruticilla) writ expresses much surprise h w th sitti g female could so soon ha g n effectual notice that she was wid w f th species as not common in th neighbourhood. M Jenner Weir has mentio ed to m n arl similar case t Blackheath h n sees hears the not of th wild bullfinch, y t when one of his caged male has d ed wild on in the course of f w da has g rall come and perched ear th wid wed f male whose call-note is not loud I will gi nly o th fact on the thorit of this sam observ one of pair of starlings (Sturnus vulgaris) was shot in the morning b noon new mat was found this was again shot, b t bef re night the pair was compl t so that the disconsolat widow or widower was thrice consoled durin

wid w or wid w r Th males of ce tain ... ma occasi nall be h ard pouring f rth their l e-so g lo g afte th prope time, sh w ng that th ha e th lost r n gained a ma e. D ath from accid nt o disease of n of pair w uld l a the the free and ingle and there is reason to beli e that f m l birds during th breeding-season are especiall liable t prem ture d th. Again, bird which ha had their nests destroyed o barren pairs, retarded indi iduals, would asily be in d ced to d sert th ir mates, and w uld probably be glad to tak what share th y could f th pl asures and duties of rearing off p ing altho gh not th ir own. Such co ti nci

*O the peregrine falcon, see Thompson, Nat. Hist. of I d nd B d vol. i., 1849, p. 39 O ls, sparrows, nd partridges, see White N t. H st. of Selborne ed. of 18..5, ol. i., p. 139 O the Phœnicura, see Loudon M g of Nat. Hist., vol. vii., 1834 p. 245 Brehm (Thierleben, B s. 991) also alludes t cases f birds thrice mated during the sam day see Whit (Nat. Hist. of S lborne 18..5, ol. p. 140) the xist ce early the seaso of small coveys of male partridges, of which fact I ha e heard other in t ces See J nner the retarded t t of the g rat rgans certain birds, Ph l. T ansact., 18 4 In regard t birds livi g in triplets, I owe t M J nn Weir the cases of the starli gs nd parrots, and t M Fox, of partrid es, car rion-crows, see th F eld 1868, p. 415 O arious

re ... act ... same district during the height of the breeding season there should be so many males and females always ready to repair the loss of a mated bird. Why do not such spare birds immediately pair together? Have we not some reason to suspect, and the suspicion has occurred to Mr. Jenner Weir, that as the courtship of birds appears to be in many cases prolonged and tedious, so it occasionally happens that certain males and females do not succeed, during the proper season, in exciting each other's love, and consequently do not pair. This suspicion will appear somewhat less improbable after we have seen what strong antipathies and preferences female birds occasionally evince towards particular males.

Mental Qualities of Birds, and their Taste for the Beautiful.—Before we further discuss the question whether the females select the more attractive males or accept the first whom they may encounter, it will be advisable briefly to consider the mental powers of birds. Their reason is generally, and perhaps justly, ranked as low; yet some facts could be given[9] leading to an opposite conclusion. Low powers of reasoning, however, are compatible, as we see with mankind, with strong affections, acute perception, and a taste for the beautiful; and it is with these latter qualities that we are here concerned. It has often been said that parrots become so deeply attached to each other that when one dies the other pines for a long time; but Mr. Jenner Weir thinks that with most birds the strength of their affection has been much exaggerated. Nevertheless when one of a pair in a state of nature has been shot, the survivor has been heard for days afterwards uttering a plaintive call; and Mr. St. John gives various facts proving the attachment of mated birds.[10] Mr. Bennett relates[11] that in China after a drake of the beautiful mandarin teal had been stolen, the duck remained disconsolate, though sedulously courted by another mandarin drake, who displayed before her all his charms. After an interval of three weeks the stolen drake was recovered, and instantly the pair recognised each other with extreme joy. On the other hand, starlings, as we have seen, may be consoled thrice in the same day for the loss of their mates. Pigeons have such excellent local memories, that they have been known to ret... ...ould remain mated for life be separated for a few weeks during the winter, and afterwards matched with other birds, the two when brought together again, rarely, if ever, recognise each other.

Birds sometimes exhibit benevolent feelings; they will feed the deserted young ones even of distinct species, but this perhaps ought to be considered as a mistaken instinct. They will feed, as shewn in an earlier part of this work, adult birds of their own species which have become blind. Mr. Buxton gives a curious account of a parrot which took care of a frost-bitten and crippled bird of a distinct species, cleansed her feathers, and defended her from the attacks of the other parrots which roamed freely about his garden. It is a still more curious fact that these birds apparently evince some sympathy for the pleasures of their fellows. When a pair of cockatoos made a nest in an acacia tree, it was ridiculous to see the extravagant interest taken in the matter by the others of the same species. These parrots, also, evinced unbounded curiosity, and clearly

n ale b rds singi g fter th proper pe iod see Rev. L. J ny s, Ob ... ons ... N t ... l H tory 1846 p. 87.

I ... gs ct pped as a decoy to ... tr y th ... ld ... es by fl ... h t i ext ... d tl ... d y h ... h ks, ... our th ... n k ll d nd th l ft tl est ... retu g ft rw rd h f u d t o m re h r t bl ind d ls tl sane rr d f m rry O of th se h k lled tl tl h ls h t, but co ld n t f nd. N ... re cam ... th l ke f n tl ss rr l.

I m d bted t ... rof N wt n f r th f ll ... g passage from M ... f N t ... list ... nut hat ... m re ... ld g ... od f tl n t ... ed h rd l ... ts. N the b rd was u bl t rs k tl h placed th m o by n n his t glass, l tly w th th ... u n that th y w ld t becou e ... ft r—an nt rest g proof f ntellig nce n th part of these b rds.

[10] ... T ... S th ... l nd k ... l ... 1849, p. 188. Dr. B ll r say (B d f N w Z al nd ... p. ...) th t ... l k ng l ry a k lled l th f m le fr tt l d ... ped refus d h r food ... d d ed of brok ... l rt.

[11] W nders g n New S th Wale vol. ... 1834 p. 62.

had "the idea of property and possessi n. n They have good m mories, f n th Zoologi cal Gardens they ha plainly recognised the r former masters aft r an int rval f some years.

B rds possess acute pow rs f observ tion E ery mated bird, course recognises ts fellow And bon tates that ce tain number of mocking-thrushes (*M mus polyglottus*) re main all the year ro nd in Louisiana, whilst — t the East rn Stat these

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different persons, as is pro ed b th tro b and perma t ant path affection whi h they sh w witho t pparent ca se to wards certain indi iduals. I ha h ard of numerous instances w th ja s, partridges, an anes, and especially b llfinches. M Hussey has described in how traordinary mann tamed partrid recognised ry body and its likes and dislikes w re ry tron This bird seemed f nd of ga colours, and no n w gown or cap could be p t o with ut catching his atte tion. Mr H witt has described th habits of some d ks (rece tl descended from wild b rds) which, t th pproach of a strange dog or cat, w uld rush h adlong int th ater and xhaust th mselves th at tempts to escape but th kn w M H witt wn d gs and cats so w ll that th would h down and bask in th sun lose to th m Th y al mo ed way from trange man, and so they would from th lady wh tt nded them if she mad an great hang in h dress. Aud bo relates that h reared and tamed wild turk which alw ran w from an strange d g this bird escaped into the woods, and some d aft rwards Audu bon saw as h tho ght, w ld turk and mad his d g chase t b t t his astonish ment, the b rd did not run w and th dog, hen h cam p, did not ttack th bird, f the m tually recognised each th as friends.

M Jenne Weir is co vinced that birds pay particular tt tio to th colours of oth bird som times t f jealou and som times as n of kinship Th h t rned

reed buntin (*Emberiza schœn iclus*) which had acquired ts black head-dress, nto his a ary and th newcomer was n noticed by an bird cept by a bullfin h, whi h i like wise black h aded This bullfinch was a ry qui t bird, and had n er before quarrelled with any of its comrades, including another reed-bunting, whi h had not as t becom black headed but the reed-bunt ng w th a black h ad was so unmercif lly tre ted th t it had to be remo ed *Spiza yanea*, d ring the breeding season, is of brigl t blue colo and tho gh gen rall peaceabl it attacked S n whi h has only the head blue and com pl t l scalped th unfortun te b rd Mr W r was also obl ged t turn out a robin, as it fi rcel ttacked all th birds in his a iary w th an red in th plumag but no other kind t actuall killed a red-breasted cross b ll, and nearl killed a goldfinch. On th oth hand, I has observed that som b rds, wh n first introduced, fl toward th species wl ch resembl th m most in colou and settle by th sides.

A mal b rd displa th ir fine plumag and oth ornam ts w th so mu h care bef re th f males, t is ob usl probable that these appreciat th beauty of th uitors. It s, h w difficult to obtain direct vidence f th ir c pacity to appreci t beauty Wh n look g glass (of b w c

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and admirat n. It pe haps th f rm ree ing which, as tated by Lord Lilf rd [2] ttra ts th ruff t w rd an bright object, so that, in th I nian I lands, t will dart d wn to a bri ht-coloured handk rc u f regardless of re peated sh ts. Th common lark is drawn d wn from th sky and caught in large numbers, b a small mirro mad to mo and glitter in th sun Is admiration or curiosity wh h l ads th magp ra n, and som oth bird t teal and secret bri ht objects, uch as sil articles o j w ls

M G uld tates that certain humm g bird decorat th out ides of th ir nests with th utmost ta t th instin t l fast n thereo be utiful p eces of flat lich n, the larg p ece th middle and th mall n th part ttached to th branch. N w and th n a prett feath is int rtwined o fastened

[1] 'Acclimatisation f Parrots,' by C Buxt n, M P *A nals nd M g of Nat Hist.*, N 1868, p. 381 *The Zoologist*, 1847-48, p. 1602.

Hew tt ld ducks, *J rnal of Horticu* Jan 13, 1863, p. 39 Audub on the ld tur ey *Ornithological Biogr phy*, vol. i., p. 14 On the mock ing-thrush, *ibid.*, vol. i., p. 110.

[2] *The Ibis* vol. ii., 1860, p. 344.

to the outer sides, the stem being always so placed that the feather stands out beyond the surface. The best evidence, however, of a taste for the beautiful is afforded by the three genera of Australian bower-birds already mentioned. Their bowers (see fig. 46, p. 463), where the sexes congregate and play strange antics, are variously constructed, but what most concerns us is, that they are decorated by the several species in a different manner. The satin bower-bird collects gaily-coloured articles, such as the bl[illegible] s of par[illegible] which it [illegible] the en[illegible] Mr. Gould found in one bower a neatly worked stone tomahawk and a slip of blue cotton, evidently procured from a native encampment. These objects are continually re-arranged, and carried about by the birds whilst at play. The bower of the spotted bower-bird is beautifully lined with tall grasses, so disposed that the heads nearly meet, and the decorations are very profuse. Round stones are used to keep the grass-stems in their proper places, and to make divergent paths leading to the bower. The stones and shells are often brought from a great distance. The regent bird, as described by Mr. Ramsay, ornaments its short bower with bleached land-shells belonging to five or six species, and with 'berries of various colours, blue, red, and black, which give it when fresh a very pretty appearance. Besides these there were several newly picked leaves and young shoots of a pinkish colour, the whole shewing a decided taste for the beautiful.' Well may Mr. Gould say that 'these highly decorated halls of assembly must be regarded as the most wonderful instances of bird-architecture yet discovered;' and the taste, as we see, of the several species certainly differs.[16]

Preference for particular Males by the Females.—Having made these preliminary remarks on the discrimination and taste of birds, I will give all the facts known to me which bear on the preference shewn by the female for particular males. It is certain that distinct species of birds occasionally pair in a state of nature and produce hybrids. Many instances could be given: thus Macgillivray relates how a male blackbird and female thrush 'fell in love with each other,' and produced offspring.[17] Several years ago eighteen cases had been recorded of the occurrence in Great Britain of hybrids between the black grouse and pheasant;[18] but most of these cases may perhaps be accounted for by solitary birds not finding one of their own species to pair with. With other birds [illegible] reason [illegible] result [illegible] ing in [illegible] proximity [illegible] which have become absolutely fascinated with each other, although living with their own species. Thus Waterton[19] states that out of a flock of twent[illegible] produced hybrid offspring. A male wigeon (*Mareca penelope*), living with females of the same species, has been known to pair with a pintail duck, *Querquedula acuta*. Lloyd describes the remarkable attachment between a shield-drake (*Tadorna vulpanser*) and a common duck. Many additional instances could be given; and the Rev. E. S. Dixon remarks that 'those who have kept many different species of geese together well know what unaccountable attachments they are frequently forming, and that they are quite as likely to pair and rear young with individuals of a race (species) apparently the most alien to themselves as with their own stock.'

The Rev. W. D. Fox informs me that he possessed at the same time a pair of Chinese geese (*Anser cygnoides*), and a common gander with three geese. The two lots kept quite separate, until the Chinese gander seduced one of the common geese to live with him. Moreover, of the young birds hatched from the eggs of the common geese, only four were pure, the other eighteen proving hybrids; so that the Chinese gander seems to have had prepotent charms over the common gander. I will give only one other case. Mr. Hewitt states that a wild duck, reared in captivity,

[16] On the [illegible] Gould, 'Intro. to the Trochilidae,' 1861, p. 19. On the bower-birds, Gould, 'Handbook to the Birds of Australia,' 1865, vol. i. pp. 444-461. Ramsay, in the 'Ibis,' 1867, p. 456.

[17] 'Hist. of Brit. Birds,' vol. ii. p. 92.

[18] 'Zoologist,' 1853-1854, p. 3946.

[19] Waterton, 'Essays on Nat. Hist.' 2nd series, pp. 42 and 117. For the following statements see, on the wigeon, 'Loudon's Mag. of Nat. Hist.' vol. ix. p. 616; L. Lloyd, 'Scandinavian Adventures,' vol. i. 1854, p. 452; Dixon, 'Ornamental and Domestic Poultry,' p. 137; Hewitt, in 'Journal of Horticulture,' Jan. 13, 1863, p. 40; Bechstein, 'Stubenvögel,' 1840, s. 230. Mr. J. Jenner Weir has lately given me an analogous case with ducks of two species.

after breeding a co pl of seasons with h r own mallard, at once shook h m off on my placing male pintail n th wat It was evidentl a case of lo at first sight, fo sh swam about the new-come caressingl th ugh he peared evid tly alarmed and a erse to her vertures of affection. From that h ur she forgot her ld partn r Wint passed by and the next spring th pintail seemed to h e become con rt t h r blandishm nts, f th y nested and produced se n or ght y ung ones.

What the charm may h been n these several cases, be nd m re n lty we cann t ven co jecture. Colour how som times comes into play for in ord to raise hybrids from th siskin (*Fri gilla pi us*) and th canary t is much th best plan, according to Bechstein, to place birds of the sam tint together Mr. Jenn Weir turned a f male canary into his ary wh re th re were male linnets, goldfinches, siskins, greenfinches, chaf finches, and th birds, in rd to see which he w ld choose but there n was any doubt, and th greenfinch carried th day They paired and produced hybrid ff pring

The fact of th f mal pref rring to pair with ne male rather than with an th f th same species is n t so lik ly to ct tten tion, as when this occurs, as w ha just seen, bet een distin t species. Th f rm cases can best be observed with d mesticated con fined t rds b t these are ften pampered by high feeding and som tim ha th ir instincts tiated t an xtrem degree Of this latter fact I could gi suffici nt proof with pigeons, and especiall with f wls, but th y cannot be here related V tiated instincts may also account f som f th hybrid uni ns also mentioned but in many f these cases the birds w re allowed to range freely ver large ponds, and there is o reason t ppose that they w re nnaturally tim lated by high feeding

W th respect to birds in a tate of nature, the first and most obvious pposition which will occur to ry ne is that th f male t the proper season accepts th first male whom she may encounte but sh has t least th opportunity f ex rtin choice, as h is almost in ariably p rs ed by man males. Audubo —and w must rem mbe that h spent long lif in pro ling about th f rests of the United States and observing th birds—does not doubt that th f male d liberat ly chooses her mate thus, peaking of a wood

peck r h says th hen is followed by half-a d zen g y su tors, who continue perf rmi g tran antics, u til a marked pref rence is sh wn fo one" Th f male of th red winged tarli g (*Ag laus pho ceus*) is lik w se p sued by se eral males, until, becoming fa tigued she alights, rece es th ir addresses, and soon mak a cho ce. He describes also h w se ral male night jars repeatedly plunge thro h the air w th astonishing rapidity sud d nly turn ng and thus making a singular n se but no soon r has the f mal made her cho ce than the oth mal s are dri en awa " W th ne of th ultures (*Cathartes au*) of the United States, parties of e ght, ten, or more males and f males assembl on fallen logs, "exhib ting th trong t d ire to please m tually and after many caresses, each male leads off his partner on the wing Audu bon likewise carefully observed the wild flocks ((er canadensis) and ge es

until ...

had mad afte which, although th y remained to th any person could asily per ce that th w re careful t keep in pairs. I ha bserved also that the ld r th birds th short w re th preliminaries of th ir court ship. Th bach lors and old maids wh ther in regret, or n t caring to be disturbed by th bustle qui tly mo ed asid and lay d wn at ... Many similar

ha learnt respecting ...

I h rece ed long l tters on this subject from Messrs. H tt and T g tm e and almost an essay from th late Mr Brent. It will be admitted by ry on that these gentl m n, so w ll known from their published w ks, are careful and xperi nced bserv rs. Th y d n t beli th t th f mal pref r certain males account of th beauty f th ir plumag b t som allowance must be mad f th artificial tate under wh ch these birds have long been kept. Mr T getm r is convinced that gamecock, th gh disfigured by being dubbed and w th his hackles trimmed

[^*]And bo *Ornithological Biogr phy* vol. i., pp. 191, 349 vol. ii., pp. 42, 275 vol. iii., p. 2.

would be accepted as readily as a male retaining all his natural ornaments Mr Brent, however admits that the beauty of the male probably aids in exciting the female and her acquiescence is necessary Mr Hewitt is convinced that the union is by no means left to mere chance for the female almost invariably prefers the most vigorous defiant and mettlesome male hence it is almost useless as he remarks to attempt true breeding if a game cock in good health and condition runs the locality for almost every hen on leaving the roosting place will resort to the game cock even though that bird may not actually drive away the male of her own variety Under ordinary circumstances the males and females of the fowl seem to come to a mutual understanding by means of certain gestures described to me by Mr Brent. But hens will often avoid the officious attentions of young males Old hens and hens of a pugnacious disposition as the same writer informs me dislike strange males and will not yield until well beaten into compliance Ferguson however describes how a quarrelsome hen was subdued by the gentle courtship of a Shanghai cock [1]

There is reason to believe that pigeons of both sexes prefer pairing with birds of the same breed and dovecot pigeons dislike all the highly improved breeds [2] Mr Harrison Weir has lately heard from a trustworthy observer who keeps blue pigeons that these drive away all other coloured varieties such as white red and yellow and from another observer that a female dun carrier could not, after repeated trials be matched with a black male but immediately paired with a dun Again Mr Tegetmeier had a female blue turbit that obstinately refused to pair with two males of the same breed which were successively shut up with her for weeks but on being let out she would have immediately accepted the first blue dragon th [illegible] ffered As [illegible] shut up [illegible] very pale [illegible] n Nevertheless as a general rule colour appears to have little influence on the pairing of pigeons. Mr Tegetmeier at my request stained some of his birds with magenta but they were not much noticed by the others

Female pigeons occasionally feel a strong antipathy towards certain males, without any assignable cause Thus MM Boitard and Corbie whose experience extended over forty five years state *Quand une femelle éprouve de l'antipathie pour un male avec lequel on veut l'accoupler malgré tous les feux de l'amour malgré l'alpiste et le chénevis dont on la nourrit pour augmenter son ardeur malgré un emprisonnement de six mois et meme d un an elle refuse constamment ses caresses les avances empressées les agaceries les tournoiemens les tendres roucoulemens rien ne peut lui plaire ni l'emouvoir gonflée boudeuse blottie dans un coin de sa prison elle n en sort que pour boire et manger ou pour repousser avec une espèce de rage des caresses devenues trop pressantes* [3] On the other hand Mr Harrison Weir has himself observed and has heard from several breeders that a female pigeon will occasionally take a strong fancy for a particular male and will desert her own mate for him Some females according to another experienced observer Riedel are of a profligate disposition, and prefer almost any stranger to their own mate Some amorous males called by our English fanciers gay birds are so successful in their gallantries that as Mr H Weir informs me they must be shut up on account of the mischief which they cause

Wild turkeys in the United States, according to Audubon sometimes pay their addresses to the domesticated females, and are generally received by them with great pleasure So that these females apparently prefer the wild to their own males.[4]

Here is a more curious case Sir R. Heron during many years kept an account of the habits of the peafowl which he bred in large numbers He states that the hens have frequently great preference to a particular peafowl They were all so fond of an old pied cock, that one year when he was confined though still in view they were constantly assembled close to the trellice walls of his prison and would not suffer a japanned peacock to touch them On his being let out in the autumn the oldest of the hens instantly courted him and was successful in her courtship The next year he was shut up in a stable and then the hen

[1] *Ra[illegible] nd Prize P[illegible] lt y* 18[illegible] p 27

[2] [illegible] n tion [illegible] *mals nd Pl nts nder Domest cat n*, vol. ii. p. 103.

[3] B[illegible] t rd [illegible] d C[illegible] l [illegible] *Le I g ns* [illegible] 1824 [illegible] 12. [illegible] pe [illegible] us as (*T[illegible] it d l'Hist Nat* t m. ii. 1850 p 200) has himself observed nearly similar f[illegible] ts w[illegible] th pigeons.

D[illegible] T[illegible] *bene* [illegible] 1824 [illegible] 60

[4] *[illegible] thological B og phy* [illegible] 13 See to th sa[illegible] ffect Dr Bryant, in Allen's *Mammals nd B ds f Flo da* p 344

all courted b s n L [28] This n al was a n panned black ged peaco k, t o ey a m b a tiful bird than the c mm n kind

L ht nst in, wh was good bse r and had cell t ppo t tes f bs at n t the C pe of Good H as ed Rudolph that the f male wid w b rd (*Ch ra progne*) diso n th male wh n r bb d f tl e l ng t il f th rs witl which h rn m nted d n g th b eding season I pres me that this bsers ti must l been mad n b rds und confin m t.[29] H an a alo g us ase D Jaeg d t r f th Zool gi cal G rd ns f V nna, tat th t mal f il ph asant wh had b n tri phant er all the males and was th accepted lo f th f mal s, had hi amental med t ly l

f assembl g and sol c t l s att nt on [30] W h seen that a tam wild-du k sed ced an unwill g p nt l d ak aft long cou t l ij Mr Bartl tt bel s that tl e Lopl pl l ke many th g ll naceou b d s n t r ll polygamous, but two f m le cann t be placed in tl e ame cage with a mal as tl e figl t so much t gether Tl e following i tance f lry s m e urprising as it r l t to bull finches, which u u lly p for l f M J nn r We ntrod ced a d ll-col u ed and ugly fe- l l i mmedi t ly at

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In all d y case th m l i so age that l nt f m le and does n t as f a. b t, as th l W tl d

portant colour is in th co tal f b rds, M Boardman, w ll kn wn collecto and bsers f b rd fo many y ars n tl N rth rn United Stat has e n hi l g pen ce een an lb p red w th an th b rd y th has had pportunit f b ri g ce t m albinos b l g t se l p ci [31] It ca hardly be m ntai ed th t alb n m tat f t re ncapabl f b eed ng as l th y can b ai ed w th th g t t fac l ty d confi m nt It pp tl f th t m l M H w tt con ceu t w m t ttrib t th f t th t th y do n t pl as t in ari bly p f s tl ld b rds p t th ject n by th mally col does n t pp ar to b in tl least infl red m ades h col h t m t p ci

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F m l b rd n t ly t l but som f case th co rt th mal figl t t g th f l p ssess S R H n to ce am tat th t w th p f wl th first ad an re th b ed me M H w tt nf m al mad by tl f m l som thi g f th m th t me h q t un tt act n sam kind tak pla d g t A d bo tl tl ld f m l f tl wild t k y W th tl percail tl f m l fl t und tl mal hilst l parad t f th plac

l g tailed d k (*H ld gl cialt*) t l as b n remarked y M Ek tr m th t t f m l m cl m co ted than the re t F q tly deed n e anind dual unded by ght m us m l

J t ly ari ty

[28] Rud lphi, *Beit ag Anth pologie*, 1812, s. 184

D D rwi sche Theor nd k Stell g Moral nd Rel gion 1872 s. 9

[29] Th tat m is gi by M A. Le th Ad ms, h *Field* nd For f R ld 1873 p. 76, nd accords th h pe nce

[30] I gard t pe f l ee S R. H ro P oc. Zool g Soc 1835 p 54 d th R E S D n, O m ntal P ult y 1848 p 8 F th turk y Au d l bid. p 4 k th cap rcalz Ll yd, G me B d f S eden, 1867 p 23

[31] M H tt, q ted T g tm P ltry Book 1866 p 165

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[21] *Rare and Prize Poultry* 1854 p 27
[22] *... Animals and Plants under Domestication* ... ii p 103

[23] B... ... *Les Pigeons* ... 1824 ... per ... (T... ...) tom ii 1850 p 206) has himself observed nearly similar facts with pigeons
[24] *Die Taubenzucht* 1824 s 86
[25] *Ornithological Biography* ... See to the same effect Dr Bryant, in Allen *Mammals and Birds of Florida* p 344

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nto two or three races or variet es wh ch d ffer
f h col uring of the tail—

lee greatly diff re t from — duce an eq al effect b th sex s, a greater ffect se th n n th oth r ow ng to som constit ti al d ff nce

Indi dual diff rences b tween th m mber of the sam pecies are admitted by ry to occur under tate f nature. S dd n nd strongly marked var t s ar rar t is also doul tf l wh th if b ficial th y w uld ft n be preserved thro gh sel ct on a d t ansm tted to cceeding ge r t ns[24] N e th l ss, t

int rmediate g adati ns ha in th s o th foll wing cases. In the males alone of on of the Aust al an p r ake ts the tl ghs n some are scarl t, in oth r grass-g een. In an ther parrakeet of t e same country some ind viduals h the band across th w ng-co erts b gl t yell w wh le in th s th am part i t ged w th ed[25] In the United States some f w of the mal s f the scarl t ta g (*Tanagra r bra*) ha a be tif l tran v rse ba d of gl wi g ed on th mall r wing-coverts but this variation i wh t rare so that its preser

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w uld n t h been w rth t ce had not this m peci possessed in south rn Indi a w ll marked occ pital rest formed f sev e al grad ated feathers.

Th f llowing case s in some respects mo t t A n ed an ty of th n w th

gists as a distin t species. The fact f the p ed b rd be g p rsued and pe ec ted w th m ch lam ur by th oth r ns f th island was th chi f cause whi h led Brünn h to con l d th t th y w re pecifically d tin t b t

gly the mporta ce f that unconscious f m of selectio by man, h f ll from th prese

[23] e g), hich has bee of m re use to m tha y other fl I did t see how g eat the hances ere gainst th prese vati of ariati ns, hether sl ght or tro gly pro nced, occurring nly in gle ndi iduals.

[24] *Int oductio the T ochilidæ* p 102

[25] G uld, *H ndbook f B d f A st alia* I, pp 32 d 68.

[26] Aud bo *O ith logical Biogr phy* 18 6, I p 389

[27] Jerdon, *B d f India*, I p. 108 d M Blyth, *Land nd Water* 1868, p 381

Whether this statement is credible I know not but the native sportsmen shoot these females in order to stuff them as decoys [2]

With respect to female birds feeling a preference for particular males we must bear in mind that we can judge of choice being exerted only by analogy If an inhabitant of another planet were to behold a number of young rustics at a fair courting a pretty girl and quarrelling about her like birds at one of their places of assemblage he would by the eagerness of the wooers to please her and to display their finery infer that she had the power of choice Now with birds the evidence stands thus they have acute powers of observation and they seem to have some taste for the beautiful both in colour and sound It is certain that the females occasionally exhibit from unknown causes the strongest antipathies and preferences for particular males When the sexes differ in colour or in other ornaments the males with rare exceptions are [illegible] more decorated [illegible] only during the [illegible] y display their [illegible] their voices and perform strange antics in the presence of the females Even well armed males who it might be thought would altogether depend for success on the law of battle are in most cases highly ornamented and their ornaments have been acquired at the expense of some loss of power In other cases ornaments have been acquired at the cost of increased risk from birds and beasts of prey With various species many individuals of both sexes congregate at the same spot and their courtship is a prolonged affair There is even reason to suspect that the males and females within the same district do not always succeed in pleasing each other and pairing

What then are we to conclud [illegible]

[illegible] female exerts a choice and that she receives the addresses of the male who pleases her most[2] It is not probable that she consciously deliberates but [illegible] excited or attracted by the most beautiful or melodious, or gallant males Nor need it be supposed that the female studies each stripe or [illegible] t of colour that the peahen for instance admires each detail in the gorgeous train of the peacock—she is probably struck only by the general effect. Nevertheless after [illegible] aring how care fully the male Argus [illegible]

[illegible] gain how the male goldfinch alternately displays his gold be-pangled wings, we ought not to feel too sure that the female does not attend to each detail of beauty We can judge as already remarked of ch[illegible] ce being exerted only from analogy and the mental powers of birds do not differ fundamentally from ours From these various considerations we may conclude that the pairing of birds is not left to chance but that those males, which are best able by their various charms to please or excite the female are under ordinary circumstances accepted If [illegible]

[illegible]

[illegible] habitual or even occasional preference by the female of the more attractive males would almost certainly lead to their modification and such modifications might in the course of time be augmented to almost any extent compatible with the existence of the species

[illegible]

[illegible] ection that domesticated birds have varied greatly their variations being inherited is certain That birds in a state of nature have been modified into distinct races is now universally admitted [3] Variations may be divided into two classes those which appear to our ignorance to arise spontaneously and those which are directly related to the surrounding conditions so that all or nearly all the individuals of the same species are similarly modified Cases of the latter kind have recently

[2] Quoted in Lloyd Game Birds of Sweden, p. 34

[3] According to Dr Blas[illegible] (Ibis [illegible] 1860 p. 297) there are 425 [illegible] birds which breed [illegible] Europe besides [illegible] frequently regarded [illegible] species. Of the latter Blasius thinks th[illegible]

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these diff nces, as w ll as all thers, m
primarily d pend n th law of vari t n On
th principl f co lated d lopme t, the
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gated, and are called hackles n w when both
se acquire top-kn t which is a n w
haract in th gen s, th feath rs on th
head f th m l becom hackl haped
d tly th principl f co rel ti whilst
those th head f th f mal are f th
ord nary hape Th col ur also f th hackles
f rmi g th t p-kn t f th mal is ften
correlated with th t f th hackles n th neck
nd loins, as m y be seen by comparing th se
f th rs in th gold n and sil r spangled
P lish, th H dans, and Cre -cœur breeds
I som natural pec s w may bse ex
actly th sam correlati n in th col urs of
these sam f th s, as in th males f th
pl ndid g ld and Amh rst ph asants

Th tru ture f ach indi dual f ther
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bases, there was n each feather a ymm t ical
cur ed zone of dark brown In som in tances
th haft of th f ather determines the dis-
tribut n of the tints thus with the body
f th rs of a m grel from the same black
Spanish cock and a sil spangled P lish hen
the haft, tog th r with a narrow space on
each side, was greenish-black, and this was
u u ded by a regular zone of da k brown
edged with brownish white. In these case we
ha f thers symm trically shaded lik those
wl h gi e so much elegance to the plumage of
many natural peci s. I ha lso n ticed a
vari ty of th comm n p geon with th wing
bars symm trically zoned w th three bright
shad nst ad of b mply black on a
slaty bl e gro nd as in the parent speci s.

In many gro ps of bird the plum is
diffe th sev ral species, yet
certa
all.
th p
bars, tho gh th y may be col red red yellow
whit black, blu th e t of th plumage
b ing f some wh lly different tint. Here i a
m e n cas in which certain m rks are
tained th gh col ured in a mann r alm t
actly the ppo t of wh t i nat ral the
boriginal p geon has a blu tail with the te
minal hal f th t w b of the tw o t r
tail feath rs wh te now th is a sub- ariety
h ing a white instead f a bl tail with
p ecisely th t part black which is wh te in th
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coat f some mammal n th sc les f rep-
til and hes, n the kin of mphib ans, on
th wi g f many Lep d pt and oth
nsects, th y d serv to b pecially n t ced
An ocell cons sts of a pot within a ri g f
an th col lk th p pil within th iris,
b t th cent al pot lt n surrounded by

in nat al species I laced and p gled f wls
the colo red margi f th f th rs are
abruptly defined b t a mo grel aised by
m from black Sp m h cock gl ssed with
green, and whit m h n, all th feath rs
re greenish black, excepting towards th ir
tremiti es h ch w re y ll wi h whit b t
betwee th whit extremities nd th black

ne cock b tt rfly (Vanessa) Mr Trim n has

[a]Bechstein, *Nat geschichte Deutschlands*, B
179 s. 31, sub- ariety f th m nck
p geon.

this is now known to be an error.[40] This case seems analogous to that lately given of albino birds not pairing from being rejected by their comrades.

In various parts of the northern seas a remarkable variety of ... guillemot ... one out of ... estima... ... sents this variation. It is characterised[41] by a pure white ring round the eye, with a curved narrow white line, an inch and a half in length, extending back from the ring. This conspicuous character has caused the bird to be ranked by several ornithologists as a distinct species under the name of *U. lacrymans*, but it is now known to be merely a variety. It often pairs with the common kind, yet intermediate gradations have never been seen; nor is this surprising, for variations which appear suddenly, are often, as I have elsewhere shown,[42] transmitted either unaltered or not at all. We thus see that two distinct forms of the same species may co-exist in the same district, and we cannot doubt that if the one had possessed any advantage over the other, it would soon have been multiplied to the exclusion of the latter. If, for instance, the male pied ravens, instead of being persecuted by their comrades, had been highly attractive (like the above pied peacock) to the black female ravens, their numbers would have rapidly increased. And this would have been a case of sexual selection.

With respect to the slight individual differences which are common, in a greater or less degree, to all the members of the same species, we have every reason to believe that they are by far the most important for the work of selection. Secondary sexual characters are eminently liable to vary, both with animals in a state of nature and under domestication.[43] There is also reason to believe, as we have seen in our eighth chapter, that ... ons are more ... e female ex ... favourable ... racters thus ... o one sex or to both sexes depends, as we shall see in the following chapter, on the form of inheritance which prevails.

It is sometimes difficult to form an opinion whether certain slight differences between the sexes of birds are simply the result of variability with sexually limited inheritance, without the aid of sexual selection, or whether they have been augmented through this latter process. I do not here refer to the many instances where the male displays splendid colours or other ornaments, of which the female partakes to a slight degree; for these are almost certainly due to characters primarily acquired by the male having been more or less transferred to the female. But what are we to conclude with respect to certain birds in which, for instance, the eyes differ slightly in colour in the two sexes?[44] In some cases the eyes differ conspicuously; thus with the storks of the genus Xenorhynchus, those of the male are blackish hazel, whilst those of the females are gamboge-yellow; with many hornbills (Buceros), as I hear from Mr. Blyth,[45] the males have intense crimson eyes, and those of the females are white. In the *Buceros bicornis*, the hind margin of the casque and a stripe on the crest of the beak are black in the male, but not so in the female. Are we to suppose that these black marks and the crimson colour of the eyes have been preserved or augmented through sexual selection in the males? This is very doubtful; for Mr. Bartlett shewed me in the Zoological Gardens that the inside of the mouth of this Buceros is black in the male and flesh-coloured in the female; and their external appearance or beauty would not be thus affected. I observed in Chil... that the ... ins in the con... ... also a small ... to think of the full-... and comb of the condo... which does not appear to us in the least ornamental? The same question may be asked in regard to various other characters, such as the knob on the base of the beak of the ...

[40] G... ba..., *T... g... b... h Re... ach F...* 1830, ss. 51-54. Macgillivray, *History of British Birds*, vol. ... p. 745. *Ib...* ... 1863, p. 469.

[41] Graba, ibid. s. 54. Macgillivray, *... b... d...* ... p. 32.

[42] *Variation of Animals and Plants under Domestication*, vol. ii. p. 9.

[43] On these points see also *Variation of Animals and Plants under Domestication*, vol. i. p. 253; vol. ii. pp. ... 3 ... 5.

[44] See, for instance, ... *Ibis*, 1860, p. 206; ... 1863, p. 4... 6.

[45] See also Jerdon, *Birds of India*, vol. i. pp. 243-245.

[46] *Zoology of the Voyage of H.M.S. Beagle*, 1841, p. 6.

any existing bird has acquired his magnificent colo rs r th r rnam nts, w ought to be- l f l e tinct p ogenit rs

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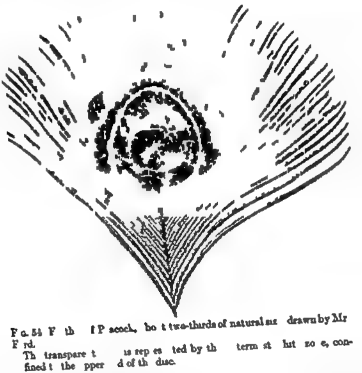
partially trace f th r form r cnarac a. Instead f entering n ted d tails re pect ing arious gro ps in whi h triki g nstances of gradati co ld be gi n t seem the best

ir descent, int nsely blue ind nted centre surro nded by ri h green zone this by a broad coppe y brown zone, and th s by five th r n rrow zone f l ghtly diff rent irides- cent hades A trifl ng characte in th d sc deser es n t ce the barbs, f a pace along n f th co ce tri zon s are m re r less d titute of th ir barb les, so that a part f th disc i urrounded by an alm st t an parent zone which gi es it a highly finished aspect. But I have elsewhere described[59] an exactly



F G. 54 F th f P acock, bo t two-thirds of natural siz drawn by Mr F rd.
Th transpare t is rep es ted by th term st hit zo e, confined t the pper d of th disc.

plan to tak n tw trongly ma ked cases f nstance th t f th peacock, d t see if l ght can be thrown n th tep by whi h th b rd l a l ecom so pl nd dly decorated

analog u ri ti n n th hackl of a s b- v ri ty f th g m -cock in wh h th t ps, h g m tall lustre are separ ted from th l w p rt f th f ther by a ymm tri cally sh ped tran.parent zo e composed f th ked porti ns f th barbs. Th low

tand separ t are decomposed b t thi is th case th th f th rs f many pec s, and th som an ti f th d m ti f wl and p geo Th barb co lesce to ard th tr m ty f th h ft f rming th al d sc ocellus, which certainly f th most bea tiful objects n th wo ld It consists f an

traces, as m y be seen in th d wing (fig 4) f ind ntat ns, r ther breaks. These nd n tat ns are comm n to th Indian and J an peacocks (P cristatus and P m t cus) and

[59] riation of Animals and Pl nts under Domestication, l. i., p. 254

sists of a black centre including a semi transparent crescent shaped mark surrounded by

ucce sive ochre yellow black ochre yellow

ments have been developed the process has probably been a simple one at least with in sects for as Mr Trimen writes to me no characters of mere marking or colouration are ■ unstable in the Lepidoptera as the ocelli both in number and size Mr Wallace who

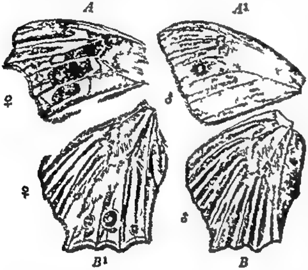


FIG 53 *Cyllo leda*, Linn from a draw ng by Mr Tri men shewing th extreme a ge f ariatio in the ocelli.

m from M urit u upp r surface f f re-

first called my attention to this subject shewed me a series of specimens of our common meadow brown butterfly (*Hipparchia janira*) exhibiting numerous gradations from a imple minute black spot to an elegantly shaded ocellus In a S African butterfly (*Cyllo leda* Linn) belonging to the same family tl e ocelli are even still more variable In some specimens (*A* fig 53) large spaces on the upper surface of the wings are coloured black and include irregular white marks and from this state a complete gradation can be traced into a toler ably perfect ocellus(1[1]) and this results from the contraction of the irregular blotches of colour In another series of specimens a grada tion can be followed from excessively minute white dots, surrounded by a scarcely visible black line(*B*) into perfectly symmetrical and

large ocelli (*B*[1]) [43] In cases like these the development of a perfect ocellus does not require a long course of variation and selecti n

With birds and many other animals, it seems to follow from the comparison of allied species that circular spots are often generated by the breaking up and contraction of stripes. In the tragopan pheasant faint white lines in the female represent the beautiful white pots in the male and something of the same kind may be observed in the two sexes of the Argus phea ant However this may be appearances

trat po nt tou a

latter is thus rendered lighter and on the other hand that a white spot ■ often formed by the colour being driven away from a central point so that it accumulates in a surrounding darker zone In either case an ocellus is the result The colouring matter seems to be a nearly constant quantity but is redistributed either centripetally or cen trifugally The feathers of the common guinea fowl offer a good instance of white pots surrounded by darker zones an l wherever the white pots are large an l stand near each other the surrounding dark zones become confluent In the same ing feat er of the Argus pheasant dark spots may be seen surrounded by a pale zone and white spots by a dark zone Thus the formation of an ocellus in its most elementary tate appears to be a simple affair By wl at fur ther steps the more complex ocelli which are surrounded by many successive zones of colour have been generated I will not pretend to ay But the zoned feathers of the mongrels from differently coloured fowls, an l the extraordinary variability of the ocelli on

f tonte n lead us to conclu le tl at

Cradation of Secondary Sexual Characters
Cases of gradation are important as shewing us tl at

acquired

liscover the actual

[43] This woodcut has been gra ed from bea ti ful draw g most ki dly mad f m by Mr Tri e see also his descript n A th d ridul am f r t n th col rat d shape of the f this butterfly n his *Rhopalocer Africa A st alis*, p. 186

Jerd n, *Birds f India*, ol iii., p. 517

each tail-covert, though till plainly betraying its double rigin. Th se confluent ocelli diff r from th singl ocelli f th peacock in h ving an indentatio t both ds, inst ad of only at the lower or basal nd Th explanati n, ho er of this diff rence is n t difficult in some species of P lyplectron the tw al ocelli on the sam f th r tand parallel to ach other in th pecies (as in I ch gus) th y con r t ward nd n w th partial confluence of tw con g nt ocelli w uld manifestl lea a much deeper ind ntati n t the di r t than t the con ergent nd It also manifest that if the con erg nce w re strongl pronounced and th conflu nce com plete, th indentati n t th co rgent nd would tend t disappear

Th f feath both peci f th pea

respect th din remains

f P lyplectro which in most of th

t

be so. Th central tail f th rs f P napoie is ha th tw ocelli n ach sid f th shaft perfectly d loped but th inn ocellus becomes less and less consp cu us n th m re exterior tail-feath rs, until m re shad w rudim t is l ft th nn sid f th ute most f th Again, in P malaccens th ocelli th tail-co rts are as we h seen, confluent and these f th rs are f unus al length, being two-thirds f th l gth f th tail-f th rs, so that in both these respects they pproach th tail-co rts f th peacock. N w in P malaccense th tw ce tral tail f athers alo are rnam ted ach with tw brightl -coloured ocelli, th inn ocellus h v ing completely disappeared from all th ther tail-feath rs. Consequ ntly th tail-co rts and tail-feathers f this pecies of P lyplectron mak ar pproach tructure and rna mentat on t th corresponding f th rs of th peacock.

As far th n, as gradation throw light th steps b whi h th magnificent train f th peacock has been acquired hardl anything more is needed If w pi ture t urselves a progenito of th peacock in an almost exactly intermediat condition betwee the xisting peacock, with his enorm usly el ngated tail co rts, rnamented with single ocelli and an ordinary gallinaceous b rd with short tail co erts, merely potted with some colour we shall see bird allied to P l plectron—that is, with tail-co rt c pable of erect on and ex pansi n rnamented with two partially co fl ent ocell and lo g en gh almost to con ceal th tail f thers, the l tt r ha ing already partiall lost th r ocelli Th indentation of th ce tral d sc and f the surrounding zone of th ocellus, in both pec es of pe cock peak plainly n fa ur of this w and i th rw se in xplicable Th males of Polyplec- tron are no do bt beautiful birds, b t their beauty wh n wed from a l ttl di tance cann t be compared with that f th peacock. Many f mal pro nitors of the peacock mu t during a lo g line of descent, l a pprec ted thus super rity f th y ha consciousl by th continued pref rence f r th m t be tiful males, rend red the peacock the most pl ndid f living b rds.

A gus ph as t.—An th r xcell nt case f in t t n is ff red by the ocell n the wing f ath rs of th Argus ph asant, wh ch are shaded n so w nd rful manne as to resem ble b loose w thin sockets, and con sequ I pr has

nced arti ts, t chance—to the f rtu t s conco rse f at ms of col uring matt r That th se rnam nts h uld h been f rmed thro gh th selecti n f many s ccessi ar ti ns, n t f which was origi all in tended to prod ce the ball and sock t ffect, seems as incred bl as that of Raph l Mad nnas sh uld ha been f med b th selecti n f chance d ub f paint made b a l g successi n of young artists, not f wh m t nded t first t d w th h man figure In rd to disco h w the ocelli h bee d l ped we cann t look to a long li f prog nitors, to many closely allied f rms, f uch d n t n w xist. But f rtu nat ly th se eral f ath rs n th wing uffice t gi u a cl t th problem and th y pro to d m nstration th t a grad ti n t l ast possibl from m re pot to a finish d ball-and sock t ocell s.

The wing f ath rs, be ri the ocelli are co red w th dark tripes (fig 57) with row of dark pots (fig 59) ach stripe row of pots running obliquely d wn th sid f th shaft to f th ocelli Th pots are

they seem to deserve particular attention as probably connected with the development of the ocellus but for a long time I could not conjecture their meaning

If we admit the principle of gradual evolution there must formerly have existed many species which presented every successive step between the wonderfully elongated tail coverts of the peacock and the short tail coverts of all ordinary birds and again between the magnificent ocelli of the former and the simpler ocelli or mere coloured spots on other birds and so with all the other characters of the peacock. Let us look to the allied Gallinaceæ for any still existing gradations The species and sub species of Polyplectron inhabit countries adjacent to the native land of the peacock and they so far resemble this bird that they are sometimes called peacock pheasants I am also informed by Mr Bartlett that they resemble the peacock in their voice and in some of their habits During the spring the males as previously described strut about before the comparatively plain coloured females expanding and erecting their tail and wing feathers, which are ornamented with numerous ocelli I request the reader to turn back to the drawing (fig 51 p 472) of a Polyplectron In *P napoleonis* the ocelli are confined to the tail and the back is of a rich metallic blue in which respects this species approaches the Java peacock *P hardwickii* possesses a peculiar top-knot which is also somewhat like that of the Java peacock In all species the ocelli on the wings and tail are either circular or oval and consist of a beautiful iridescent greenish blue or greenish purple disc with a black border This border in *P chinquis* shades into brown edged with cream colour so that the ocellus is here surrounded with variously shaded though not bright concentric zones The unusual length of the tail-coverts is another remarkable character in Polyplectron for in some of the species they are half and in others two-thirds as long as the true tail feathers The tail-coverts are ocellated as in the peacock. Thus the several species of Polyplectron manifestly make a graduated approach to the peacock in the length of their tail-coverts in the zoning of the ocelli and in some other characters.

Notwithstanding this approach the first species of Polyplectron which I examined almost made me give up the search for I found not only that the true tail feathers which in the peacock are quite plain were ornamented with ocelli but that the ocelli on all the feathers differed fundamentally from those of the peacock in there being two on the same feather (fig 55) one on each side of the shaft.

FIG 55 Part of a tail covert of *Polyplectron chinquis* with the two ocelli of natural size.

Hence I concluded that the early progenitors of the peacock could not have resembled a Polyplectron But on continuing my search I observed that in some of the species the two ocelli stood very near each other that in the tail feathers of *P hardwickii* they touched each other and finally that on the tail-coverts of this same species as well as of *P malaccense* (fig 56) they were actually confluent As the

FIG 56 Part of tail covert of *Polyplectron malaccense* with the two ocelli partially confluent. of natural size.

central part alone is confluent an indentation is left at both the upper and lower ends and the surrounding coloured zones are likewise indented A single ocellus is thus formed on

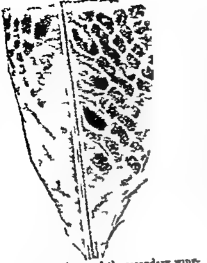


FIG. 58 Basal part of the secondary wing-feather nearest to the bod

described basal pots, t g th with th next higher one in t sam row to a curious ma-ment, which cannot be called an ocellus, and hich I al name from th want of bett term, an liptic orname t. These are sh wn in the accompan in figure (fig. 9) W here see several oblique row A B C D &c (see the lett red diagram on the right hand) of dark pots of the usual charact Each row of spots runs down to nd is connected with one of the liptic ornaments, in exactl the same manne as each stripe in fig. runs down to, and is connected with, on of the ball-and socket ocelli. Lookin t an on row for instance B in fi 9 the lowest mark (b is thicke and cons lerab v longer than the ppe spots, and has ts left trem t pointed and curved upwards. This black mark is brupt l bordered on t pper s b rathe broad space of richl haded tints, beginnin th narrow brown zo hich passes to oran and this into pale leade ts t. with the nd towards the shaft much pale These shaded tints together ll p the whol inner space of the liptic ornament. The mark (b corresponds in ery respect with the basal shaded spot of the simple feathe described in the last paragraph (fig. 58) b t is more highly developed and more brightly coloured. Abo e and to th right of this spot (b fig. 59) with ts bright shading there s a long narrow black ma (c) belo ging to the sam row and whi h rched a littl d wn wards so as t face (b) Thi ma k is som t mes brok n into two port ns. It is also narrow l ed ed n tl low r id with a ful ous tint. To th l ft of and bo e ( ) the same obl que direction, but alwa s m re o less distinct from it, there is anoth r black mark (d) This mark is g nerall sub-triangular and irregular in shape b t in th on lett red n the diagram I is unusuall narrow lo gated, and regular It appar ntl consists of lat ral and broken pro-longation of the mark ( ) togeth with ts confl nce w tl a broken and prolon ed part of th next spot bo e b t I do not feel sure f this. These three marks, b and d with th int rvening bright shades, form to th r th so-called liptic ornam nt. These ornam nts placed parall l to tl e haft, manifestly corre spond in po tion w th th ball-and-sock t ocelli. Th trem ly l gant ppearance cann t be ppreciated in th drawing, as th orange and leaden tints, contrasting so w ll with the black marks, cannot be sh wn.

Between one of th lliptic ornam nts and a

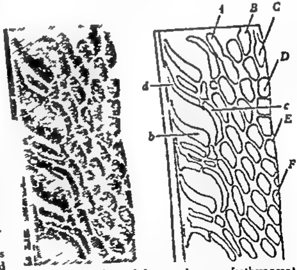


FIG. 9 Portio of ne of the secondary wing-feathers near t the body shewing the so-called iptic ornaments. The right hand figure is gi e merely as diagram for th sake of the letters of reference.

A B C D &c. Rows of spots running down to and forming the eliptic ornaments b. Lo est spot or mark in row B c. The ne t succeedi spot or mark in the same row d. Apparently broken prolongatio of the spot c. in the same row B.

FIG 57 Pa t cf ndary wing f th r of Argus pl asant l ing two p rfect ocell

to the left of the haft has been c t ff]

generally elongated in a line transverse to the row in which they stand They often become confluent either in the line of the ro —and then they form a longitudinal stripe—or transversely that is with the pots in the a l joining rows and then tl ey form transverse stripes A spot sometimes breaks up into smaller spots which still stand in their proper places

It will be convenient first to describe a per fect ball and socket ocellus This cons ts of an intensely black circular ring surrounding a pace ha led so as exactly to re emble a l all The figure here given has been a lmirably drawn by Mr Ford and v ll engrave l but a woodcut cannot exhibit the exquisite hadi g of the original The ring is almo t always sligl tly broken or interrupted (see fig 7) at a point in the upper half a little to the right of and above the white shade on tl e enclose l ball it is also sometimes broken towards the base on the right hand Tl ese littl breaks have an important meaning Tl e ring is al ways much thickened with the edges ill defined towards the left hand upper corner the feather being held erect in the position in which it is here drawn Beneath this thickened part there is on the surface of the ball an ob li que almost pure white mark, which shades off downwards into a pale leaden hue a l thus into yellowish and brown tints, which in sensibly become darker and darker towards the lower part of the ball It is this shading which gives o admirably the effect of light shining on a convex surface If one of the balls be examine l it will be seen that tl e lower part is of a brown tint and is indistinctly sep arated by a curved oblique line from the upper part which is yellower and more leaden this curved oblique line runs at right angles to the

woodcut does not in the least interfere with the perfect shading of the ball It should be particularly observed that each ocellus stands in obvious connection either with a dark stripe or with a longitudinal row of dark spots for both occur indifferently on the same featl er Thus in fig 57 stripe A runs to ocellus a B runs to ocellus b stripe C is broken in the upper part and runs down to the next suc ceeding ocellus not represented in tl e wood cut D to the next lower one and so with the stripes E and F Lastly the several ocelli are separated from each other by a pale surface bearing irregular black marks

I will next describe the other extreme of the series namely the first trace of an ocellus. The short secondary wing feather (fig 58) nearest to the body is marked like the other featl ers, with oblique longitudinal rather irregular ro s of very dark pots The basal pot or that nearest the shaft in the five lower rows (excluding the lowest one) is a little larger than the other spots of tl e same row and a little more elongated in a transverse direction It differs also from tl e otl er pots by being bordered on its upper side with some full fulvou shading But tl is pot is not in any way more remarkable tl an tl ose on the plum

ing wing feathers an absolutely insen ble gradation can be traced from one of the last

r a ph tograph,

wh h
g en n
as n th ~
the f ath s wl cl a h ld p rp u
th l te ma ks n the ocelli repre ent ng
l ght reflected from a con x urface are at tl
upper f tl er nd tl at s, r di ectc l
upward and th b rd wh lst d splay ng him
self n the g ound w uld n tu ally be llumi
nated from bo e But he a com tl rious
po t tl ter f ath s are held alm t h ri
llew s t
zo
ap
seq
on the ppe des of the oc
as s th fact, they are thus plac d! Hence th
ocell n the se r l fe th rs th ugh occupy
ing ery d ff re t po ti s witl re pect to the
l ght, ll ppear as f llumi ted f om ab e
ju t as an t t w uld h l aded tl m
N erth l ss tl ey ar n t ll m ted from
tri tly th same po nt as they o ght to b f
th whit m rks n th ocelli of the f ath rs
wh ch h ld alm t l n ontally placed
th too m ch t w ds the furth nd tl t
th y ar n t uffi ntly late l We ha e
h w no r ght to xpe t bsol t p rfecti n
n a p t ende d nam tal thr ugl ual
select any m than w ha n a part
mod fied th gh natu al select n f l use
f r n tance that w ndro o g n th hu
t d w k w what H lmh ltz the

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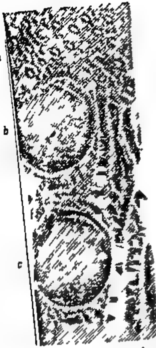

F 61 P rti ea mm t f f th secondary g f th rs, bear g p fect ball d k t oc lli.

a. O nam ted ppe p rt b t pp rmost, mp rfect b ll d sock t oc llus. (Th had g bo th h t m k th sum m t f th ocellus h l tll tood d k)

c. P rfect ocellus

broh prol g t f m th t l gl pot
From tl abse f tl ppe and th k ed
part f tl ri th ppe m t ocell s, tl gh
1 t respects ppe as f ts
1

l pe f t than th th f tl s, and

are tl co t ar fte brok p into
mall p ts, so th t tw three row run
d w t th sam oc ll

Tl till remain an th ry curi us
po t, fir t bserved by Mr T W Wood

m t 1

l f ll ed f m mpl pots to th w
f l b ll and ocket rn m nts M G ld
wh h dly e m som f th e f tl
f lly agree w th m in th mpl t ness f tl
g ad t on It b s th t th tag in
d l pm nt exl b ted by tl e feath rs n the
sam b rd d n t t ll nece sarily sh w us th
t p passed tl ro gh by th xtin t p g m
to f th pec b t th prob bly g e u
th l t th act l t p and th y at l ast
p to d m nst t n th t a g ad t is
po bl B ar ng m nd h w ar fully the
mal A g pl asant displ y his plum b
f tl f mal as w ll as the many f ts
d g t p b bl th t f mal b d p f

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perfect ball and socket ocellus the gradation is so perfect that it is scarcely possible to decide when the latter term ought to be used The passage from the one into the other is *effected by* the elongation and greater curvature in opposite directions of the lower black mark (*b* fig 59) and more especially of the upper one (*c*) together with the contraction of the elongated sub triangular or narrow mark (*d*) so that at last these three marks become confluent forming an irregular elliptic ring This ring is gradually rendered more and more circular and regular increasing at the same time in diameter I have here given a drawing (fig 60) of the natural size of an ocellus not as

FIG 60 An oc llu in an nt rmed ate cond ti n betwe n th ll ptic o am t and the p rfect ball and ocket c llus

yet quite perfect The lower part of the black ring is much more curved than is the lower mark in the elliptic *ornament* (*b* fig 59) The upper part of the ring consists of two or three separate portions and there is only a trace of the thickening of the portion which forms the black mark above the white shade This white sh l

t

... or four *elongated* black marks by which the ring has been formed may often be detected The *irregular sub triangular or narrow mark* (*d* fig 59) manifestly forms by its contraction and equalisation the thickened *portion* of the ring above the white shade on a perfect ball and socket ocellus The lower part of the ring is invariably a little thicker than the other parts (see fig 57) and this follows from the lower black mark of the elliptic ornament (*b* fig 59) having originally been thicker than the upper mark (*c*) Every step can be followed in the process of confluence and modification and the black ring which surrounds the ball of the ocellus is unquestionably formed by the union and modification of the three black marks *b c d* of the elliptic *ornament.* The irregular zigzag black marks between the successive *ocelli* (see again fig 57) are plainly due to the breaking up of the somewhat more regular but similar marks between the elliptic ornaments

The successive steps in the shading of the ball and *socket ocelli* can be followed out with equal clearness The brown orange and pale leadened narrow *zones* which border the lower black mark of the elliptic ornament can be seen *gradually* to become more and more *softened* and *shaded* into each other with the upper lighter part towards the left hand corner *rendered still lighter* so as to become *almost* white and at the same time more contracted But even in the *most perfect ball and socket* ocelli a slight difference in the tints though not in the shading between the upper and lower parts of the ball can be perceived as before *noticed* and the *line of separation* is *oblique* in the same direction as the bright coloured shades of the elliptic ornaments Thus almost every minute detail in the shape and colouring of the ball and socket ocelli can be shown *to follow* from *gradual changes* in the elliptic ornaments and the development of the latter can be traced by equally *small steps from the* union of two almost simple spots the lower one (fig 58) having *some dull fulvous shading* on its upper side

The extremities of th ... secondary ... and sock t ... g 61) The ... cease upwards and become confused and above th limit the whole upper end of the feather (*a*) is covered with white *dots* surrounded by little black rings standing on a dark ground The oblique stripe belonging to the uppermost ocellus (*b*) is barely represented by a very short irregular black mark with the usual curved transverse base As this stripe is thus abruptly cut off we can *perhaps understand* from what has gone before how it is that the upper thickened part *of the ring is* here absent for as before stated this thickened part apparently stands in some relation with a

performers b t hether the most bea tiful the most pugnaci u was the accepted su tor I know not. M G uld, aft r describing the peculiar pluma of the L rostict adds, th t ornament and vari t is th sol object I ha n sed b t l ttle d ubt [*] If this be admitted we can perce v that the males wh cl ring f rmer times w re decked in th most el gant and no l mann would ha e gained an ad antage n t in the ordinary struggl f r lif but in ri alry with otl er males, and would have l ft a larg r numbe f off prin to inh rit th ir newly acquired bea ty

* Introduction to the Trochilidae 1861 p. 110.

the more attractive males; no one who admits the agency of sexual selection in any case will deny that a simple dark spot with some fulvous shading might be converted, through the approximation and modification of two adjoining spots, together with some slight increase of colour, into one of the so-called elliptic ornaments. These latter ornaments have been shewn to many persons, and all have admitted that they are beautiful, some thinking them even more so than the ball-and-socket ocelli. As the secondary plumes became lengthened through sexual selection, and as the elliptic ornaments increased in diameter, their colours apparently became less bright; and then the ornamentation of the plumes had to be gained by an improvement in the pattern and shading; and this process was carried on until the wonderful ball-and-socket ocelli were finally developed. Thus we can understand—and in no other way as it seems to me—the present condition and origin of the ornaments on the wing-feathers of the Argus pheasant.

From the light afforded by the principle of gradation—from what [illegible] of the immature plumage of young birds—we can sometimes indicate, with a certain amount of confidence, the probable steps by which the males have acquired their brilliant plumage and various ornaments; yet in many cases we are involved in complete darkness. Mr. Gould several years ago pointed out to me a humming-bird, the *Urosticte benjamini*, remarkable for the curious differences between the sexes. The male, besides a splendid gorget, has greenish-black tail-feathers, with the four *central* ones tipped with white; in the female, as with most of the allied species, the three *outer* tail-feathers on each side are tipped with white, so that the male has the four central, whilst the female has the six exterior feathers ornamented with white tips. What makes the case [illegible] r. Gould does not know a single species besides the Urosticte in which the male has the four central feathers tipped with white.

The Duke of Argyll, in commenting on this case,[54] passes over sexual selection, and asks "What explanation does the law of natural selection give of such [illegible] es as [illegible] s one species alone so as to have acquired white tips. The variations may have been gradual, or somewhat abrupt as in the case recently given of the humming-birds near Bogota, in which certain individuals alone have the "central tail-feathers tipped with beautiful green." In the female of the Urosticte I noticed extremely minute or rudimental white tips to the two outer of the four central black tail-feathers; so th [illegible] white tips, together with the small white ear-tuft, certainly add, as the Duke of Argyll admits, to the beauty of the male; and whiteness is apparently appreciated by other birds, as may be inferred from such cases as the snow-white male of the bell-bird. The statement made by Sir R. Heron should not be forgotten, namely, that his peahens, when debarred from access to the pied peacock, would not unite with [illegible] the Urosticte should have been specially selected for the sake of ornament, for the next succeeding genus in the family takes its name of Metallura from the splendour of these feathers. We have, moreover, good evidence that humming-birds take especial pains in displaying their tail-feathers; Mr. Belt,[55] after describing the beauty of the *Florisuga mellivora*, says, "I have seen the female sitting on a branch, and two males displaying their charms in front of her. One would shoot up like a rocket, then suddenly expanding the snow-white tail, like an inverted parachute, let himself descend in front of her, turning round gradually to show off back and front. . . . The expanded white tail covered more space than all the rest of the bird, and was evidently the grand feature in the performance. Whilst one male was descending, the other would shoot up and come slowly down expanded. The entertainment would end in a fight between the two

[54] *The Reign of Law*, 1867, p. 247.

[55] *The Naturalist in Nicaragua*, 1874, p. 112.

there can be no doubt that th male h brid ce pring would have a much lo er tail than ...at of the pure offsprin of th common pheasant. On the th r hand, if th femal co...mon pheasant, with a tail much longe than that of the f mal Sœmmerring ph asant were crossed with the mal of th latt the male hybrid ff pring would ha e a much shorter tail than that of th pure off pring of Sœmmerring pheasant.

Our fancier in ord t mal his n w breed ...h the males of a pale-bl e tint, and th f males unchan ed w uld ha to co t selecting th males during many gen rations and each stage of paleness would ha to be fixed in the males, and rendered lat nt n th females. The task w uld be an xtremel diffi cult one and has ne r been tried, b t m ght possibl be success ll carried t. Th hi f obstacle would be th l and complet loss of the pale-bl tint from th necessit of re erated crosses w th tl lat f male the latter not having t first any latent t nd ncy to produce pale-bl off prin

...mission t th male sex, th task of mak ...g new breed of th desired kind would be as for such males w ld simpl ha e t be selected and matched w th ordinary f males. An analogous case has actuall occurred, f there are breeds of th pigeon in Belgi m in ...ich the male lon are marked w th bla k striae. So ...gain M T g tm e has recentl shewn that dragons not rarely prod ce l coloured birds, which are almost alw l ns and he himself has bred t n such f mal s. It is on the other hand a rs unusual t he a sil er male is prod ced so that noth ould be asier if desired, than t mak breed of dragons with bl males and il f males. This t ndency is indeed so trong, that h n Mr Te- tmei t last g t a sil male and matched him with one of th silver females, h expected t get breed w th both se es thus coloured b was how disappoi ted, f th young male re erted t th blue colour of his grandfath the you g female alone be g silv No doubt with patience this t nden to re ersion in the males, reared from an occa sional silver male matched with a sil r h n might be elimin ted and then both sexes w uld be colo red al ke and thus ery process has been followed w th ccess by Mr Esquil ant the case of sil e turb ts.

W th fowls, ariati ns of colou limited in th ir transmission to th male sex, habitually occur Wh n this f rm of inh ritance pre ails, t might well happen that som of th ucces- e ari ti n would be transf rred t th femal who w uld th n slightl resembl the mal as actually occ rs in som breeds. Or again, the gre t n mber but not all, of the ccessi e t ps mig t be transferred to both sexes, and the f mal would th n closel re- semble th mal Th re can hardly be doubt that th t tl ca se of th mal po te p con ha g a som what larg crop, nd f th ...rg f ...and the ll and h had no wist that th se har act rs sho ld be m re tro gl displa ed n th mal than in th f mal et this th case with both breeds.

Th sam process w ld ha e to be f llowed and th sam difficult es ncount red, f t w re desired to mal a breed w th th f males alo of som n w colo

Lastl a fanci m ht wish t mak a breed w th th two se es diff ring from ach oth and both from th parent species. H re th d fficult would be trem unless the success ariations w re from th first sex all lim ted n both sides, and then th re w ld be n d fficult W see tl with th f wl thus tl t se es of th pencilled Hamb rgh d ffer ere tl from ach oth and from th two se es of th aboriginal *Gallus bank.* and both are n w k pt constant to their standard of celle ce b continued selection, whi h w uld be impossible unless th distin ti e charact rs of both were limited in th ir trans- m sion

Th panis f wl off rs a more curio case th m le has an imm nse comb but som f th uccess ariati ns, b th accumulation of hich t was acquired ppear t ha e been transf rred t th f male for she has comb man t mes lar than that of th f males f th parent pecies. B t th comb of th f mal diff rs in respect from that f th mal f t is pt t lop r and w thin a recent period

[1] Temminck says that the tail of the female *Pha- sia Sœmmerri* ...l six inches long, *Pl nche coloré* ...ol. ... 1838, pp. ... and ... the measure- ments above gi en were made for me b Mr Sclater For the common pheasant, see Macgillivray *His- tory of British Birds* vol. i., pp. 118-121

[2] Dr. Chapuis, *Le Pigeon Voyageur Belge* 1865, p. 8

[3] *The Field*, Sept., 1872.

CHAPTER XV

BIRDS—*Continued*

We have in this chapter to consider why the females of many birds have not acquired the same ornaments as the male and why on the other hand both sexes of many other birds are equally or almost equally ornamented? In the following chapter we shall consider the few cases in which the female is more conspicuously coloured than the male

In my *Origin of Species*[1] I briefly suggested that the long tail of the peacock would be inconvenient and the conspicuous black colour of the male capercailzie dangerous to the female during the period of incubation and consequently that the transmission of these characters from the mal [illegible]

[illegible] instances but after mature reflection on all the facts [illegible]

[illegible] from the first limited in their transmission to the same sex in which they first arose Since my remarks appeared the subject of sexual colouration has been discussed in some very interesting papers by Mr Wallace who believes that in almost all cases the successive variations tended at first to be transmitted equally to both sexes but that the female was saved through natural selection from acquiring the conspicuous colours of the male owing to the danger which she would thus have incurred during incubation

This view necessitates a tedious discussion on a difficult point namely whether the transmission of a character which is at first inherited by both sexes can be subsequently limited in its transmission to one sex alone by means of natural selection We must bear in mind as shown in the preliminary chapter on sexual selection that characters which are limited in their development to one sex are always latent in the other An imaginary illustration will best aid us in seeing the difficulty of the case we may suppose that a fancier wished to make a breed of pigeons in which the males alone should be coloured of a pale blue whilst the females retained their former slaty tint As with pigeons characters of all kinds are usually transmitted to both sexes equally the fancier would have to try to convert this latter form of inheritance into sexually limited transmission All that he could do would be to persevere in selecting every male pigeon which was in the least degree of a paler blue and the natural result of this process if steadily carried on for a long time and if the pale variations were strongly inherited or often recurred would be to make his whole stock of [illegible]

[illegible] complete loss of the pale blue tint for the primordial slaty colour would be transmitted with prepotent force Supposing however that some pale blue males and slaty females were produced during each successive generation and were always crossed together then the slaty females would have if I may use the expression much blue blood in their veins for their fathers grandfathers &c will all have been blue birds Under these circumstances it is conceivable (though I know of no distinct facts rendering it probable) th [illegible]

[illegible] their male offspring their female offspring still inheriting the slaty tint If so the desired end of making a breed with the two sexes permanently different in colour might be gained

The extreme importance or rather necessity in the above case of the desired character namely pale blueness being present though in a latent state in the female so that the male offspring should not be deteriorated will be best appreciated as follows the male of Sœmmerring's pheasant has a tail thirty seven inches in length whilst that of the female is only eight inches the tail of the male common pheasant is about twenty inches and that of the female twelve inches long Now if the female Sœmmerring pheasant with her short tail were crossed with the male common pheasant

1 Fourth edition 1866 p 241
2 *Westminster Review* July 1867 *Journal of Travel* vol. i., 1868, p [illegible]

sace ha been modified b sexual selection, the females having been left unchanged, or only partial and indirectly thus changed o ether the f males ha been pecially modi fied through natural selection fo th sak of protection. I will therefore discuss this q s- tion at som length, en more full than ts intrinsic importance deserves f various curi ous collateral points ma thus be con eniently discussed.

Before w ente on the ubject of colour more especial in ref rence to Mr Wallace conclusions, t ma be useful to discuss some other sexual differences under a similar point of view A breed of f wls form rly xisted in Germany[1] in which the hens w re furnished

probable that with the f males f th wild Gallinaceæ the lev lopment of sp rs had been checked through natural selection, from th injury thus caused to their nests. This seemed all the more probable as win sp rs, which ould not be injurious d ring incubation, are often as well d loped in the f male as in the male though in not a f w cases they are rathe larger in the male. Whe th male is furnished with leg-spurs th f male almost al ex hibits rudiments of th m,—the rudiment

sequently bee lost thro gh disuse or natural selection. B t if this view be admitted, t would ha e to be xtended to inn m rabl th cases and t imposes that the femal pro eni tors of the xisting spur-bearing species were once encumbered th an injurious ppendage.

In some few genera and species, as in Gallo- perdix, Acomus and th J an peacock (*P mu ticus*) the females, as ll as the males,

purs so that the spurs ha not bee remo ed Or are to suppose that th f males of these severa pecies especiall require pu s for their defence It is more probable conclusion that both the presence and al sence of purs in the females result from different la f inheri

tance ha ing prevailed ind pendently of natural selecti n W th th many f males in which spurs ppear as rudim nts, we may concl d that som f w of th ucces e vari tions, through which th y were d eloped in th males, occurred ry earl in life, and w re consequently tran ferred to th f males. In the oth and much rare cases, in which th fe- males possess full de loped purs, w may conclud that all the successi e ariations were transf rred to them and that they gradu ally acquired and inherited th hab t of not disturbing their nests.

Th ocal organs and the f athers rarious modified f producing sound as w ll as the prope instincts f u ing them ften diff r n the two sexes, b t are som times the sam in both. Can ch diff rences be accounted fo by th males ha in acquired these organs and instincts, whilst the f males ha been sa ed from inh riting them, n account of the danger t which the woul l ha been xposed l y ttracting the attention f bird r beasts of pre This does not seem to m probable, wh w th nk of th m lt tude of birds which with impunit gladd n th country w th th ices durin th spring It a saf conclusion that, as ocal and instrumental o gans are f pecial service onl to the males durin their court ship, these organ w re de eloped thro gh sexual selection and their con tant use in that se also —th successi variations and th ffects of use ha in been from the first more o less limited in transmission to the male off pring.

Many analog us cases co ld be adduced those f instance of the plumes on th h ad bein neral longe in th mal than in the f male som times of equal l ngth in both se es, and occas onally absent in the f male — these se al cases occurring n th same group of birds. It would be difficult t account for uch diff rence between the sexes by the f mal having been benefited b possessin a slightl short crest than th ma and ts consequ nt diminution or complet uppres- sion thro gh natural selection. B t I will take more f vourab case nam ly the length of the tail. The lo train of the peacock w uld ha been not onl incon nient but dang ous t th peahen durin th period of incuba-

[1] Bechstein, *Naturgeschichte Deutschlands* 1793, B ii 339

Daines Barrington, however thoug t probable (*Philosophical Transactions* 1773, p. 164) that few female birds sing beca se the talent w uld have bee da gerous t them durin ncubatio H adds, that similar iew m y possibl account for the inferiority of the female to the male in plumage

it has been ordered by the fancy that this should always be the case and success has quickly followed the order Now the lopping of the comb must be sexually limited in its transmission otherwise it would prevent the

the male must likewise be a sexually limited character otherwise it would prevent the comb of the female from lopping over

From the foregoing illustrations we see that even with almost unlimited time at command it would be an extremely difficult and complex perhaps an impossible process to change one form of transmission into the other through selection Therefore without distinct evidence in each case I am unwilling to admit that this has been effected in natural species On the other hand by means of successive variation which were from the first sexually limited in their transmission there would not be the least difficulty in rendering a male bird widely different in colour or in any other character from the female the latter being left unaltered or slightly altered or specially modified for the sake of protection

As bright colours are of service to the males in their rivalry with other males such colours would be selected whether or not they were transmitted exclusively to the same sex Consequently the females might be expected often to partake of the brightness of the males to a greater or less degree and this occurs with a host of species If all the successive variations were transmitted equally to both sexes the females would be indistinguishable from the males and this likewise occurs with many birds If however dull colours were of high importance for the safety of the female during incubation as with many ground birds the females which varied in brightness or which received through inheritance from the males any marked accession of brightness would sooner or later be destroyed But the tendency in the males to continue for an indefinite period transmitting to their female offspring their own brightness would have to be eliminated by a change in the form of inheritance and this as shewn by our previous illustration would be extremely difficult The more probable result of the long continued destruction of the more brightly-coloured females supposing the equal form of transmission to prevail would be the lessening or annihilation of the bright colours of the males owing to their continual crossing with

frequently were not eliminated yet they would not be favoured or selected for the male usually accepts any female and does not select the more attractive individuals consequently these variations would be liable to be lost and would have little influence on the character of the race and this will aid in accounting for the females being commonly duller coloured than the males

In the eighth chapter instances were given to which many might here be added of variations occurring at various ages and inherited at the corresponding age It was also shewn that variations which occur late in life are commonly transmitted to the same sex in

limited transmission can thus be accounted for It was further shewn that if a male bird varied by becoming brighter whilst young such variations would be of no service until the age for reproduction had arrived and there was competition between rival males But in the case of birds living on the ground and commonly in need of the protection of dull colours bright tints would be far more dangerous to the young and inexperienced than to the

natural selection on the other hand the males which varied in this manner when nearly mature notwithstanding that they were exposed to some additional danger might survive and from being favoured through sexual selection would procreate their kind As a relation often exists between the period of variation and the form of transmission if the bright coloured young males were destroyed and the mature ones were successful in their courtship the males alone would acquire brilliant colours and would transmit them exclusively to their male offspring But I by no means wish to maintain that the influence of age on the form of transmission is the sole cause of the great difference in brilliancy between the sexes of many birds

When the sexes of birds differ in colour it is interesting to determine whether the males

D. ke of Argyll remark that a large d med nest is more consp cu to an e my pe-cially to all tree ha ting carn rous an mals, than malle pen e t. \ must we f g t th t with m y b rd whi h b ld pen n ts,

birds in th U ted St tes, th male being vermilion, and th f male light brownish green. \ w if brilliant colo had been x tremely dangerous t bird whil t tting n their pe ests, th mal s in these cases wo ld ha suff red greatly. It might, h we e b f such paramount importance to th mal to be brilliantl colo red in rd t be t his r als, that this ma ha m re than compensated som add tional dang

Mr Wallace admits that with th king cro (D crurus) m les, and Pittidæ th f males are consp ly col red y t build pe ests b t h ges th t th birds f th first group are highly p gnac and could def nd th msel es th t th se of the seco d group take e trem ar in co cealing th pe nests, b t this does t ariably l ld good and that with th b d f th third group the f males are brightl col ured lu fly the und surface. B des th se cases, p eous hich are som tim brightly and

xposed ests. In anoth larg family that f the humming-birds, all th peci bu ld pen nests, y t th som f th most g geous species th sexes are alik and in th majority the f males, th gh less brill ant than th males, are brightl colo ed. \ can t be maintained that all f mal h mm g birds, hich are brightl colo red sc pe d tect n by th ir tints be ng green, f som display n their ppe urfaces red bl and th colours.[18]

In regard to birds whi h b ild in hole o constru t d med n sts, the ad antages, as M Wallace remarks, bes d s concealment are gained u h as h lt r fro n tl ain, gre ter warmth and in h t countrie protecti n from the un so th t t is no al d object on to his v w th t many b rds h ing both sex s obsc rely col ured b ld concealed n ts.[19] The femal H rn b ll (B ceros) for nstance of Ind a and Africa is protected d ring the ba th xtraordinary care f r sh plast rs

h r h is th k pt a close prison d ring th whol period f incub t n v t f male H rn bills are not m re con p o sly colo red than many oth b rds f eq al ze wh ch build open nests. It a m re serious bjection to M Wallace s w as is admitted by him that in som f w gro p th male are brill

se ral f the A tralian h ney suck rs or M l phagidæ.[17]

If w look to the bird of England w shall see that th re is no close and g n ral rel t on between th colours f th f male and th n tur f th ne t wh ch is constructed. Abo t f rty f Brit h b rd (e l ding those f larg siz whi h co ld d f nd th msel e) build n h les b ks, rocks, o trees, co struct d med n ts. If w tak th col rs f th f m l g ldfi h bullfinch black b rd as tandard f th d gree f consp c usness, which is n t l ghl dang rous t th tting f mal th n t f th bo f rty b rds the f m les f nly tw l an be cons d red as co p cu to dan ro d gree th remain

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Journal of T l, ed ted by A. Murray l. ., 1868, p. 2[?]

Audubon, *Ornithological Biogr phy* ol. p.

consp cu us f males could be g n. See Mr G uld magnifice t w k this family

M Sal ticed Guat mala (*Ibis* 1864 p. 3) that humm g-birds were m ch m unwill ing t le e their est during ery h t w th whe th sun was hin g brightly as if their ggs would be thus jured tha dur g cool, cloudy

the female *La porna porphyrurus* is blackish-gree the pper urface with the lores d sides of th throat crimso the female *Eul mpas j gularis* has the top of the head d back green, b t th lo ns nd the tail are crimson. M y the instances of highly

365 383, 387 389 391 414

Mr C H rne, *Proc Zoolog Soc.*, 1869 p. 243

O the ubificati d colours of these latter pecies, see G uld *H ndbook f the B ds f Aust* l L pp. 504 27

tion and whilst accompanying her young. Hence there is not the least *a priori* improbability in the development of her tail having been checked through natural selection. But the females of various pheasants, which apparently are exposed on their open nests to as much danger as the peahen, have tails of considerable length. The females as well as the males of the *Menura superba* have long tails, and they build a domed nest, which is a great anomaly in so large a bird. Naturalists have wondered how the female Menura could manage her tail during incubation; but it is now known[8] that she "enters the nest head first, and then turns round with her tail sometimes over her back, but more often bent round by her side. Thus in time the tail becomes quite askew, and is a tolerable guide to the length of time the bird has been sitting." Both sexes of an Australian kingfisher (*Tanysiptera sylvia*) have the middle tail feathers greatly lengthened, and the female makes her nest in a hole; and as I am informed by Mr R. B. Sharpe these feathers become much crumpled during incubation.

In these two latter cases the great length of the tail feathers must be in some degree inconvenient to the female; and as in both species the tail feathers of the female are somewhat shorter than those of the male, it might be argued that their full development had been prevented through natural selection. But if the development of the tail of the peahen had been checked only when it became inconveniently or dangerously great, she would have retained a much longer tail than she actually possesses; for her tail is not nearly so long, relatively to the size of her body, as that of many female pheasants, nor longer than that of the female turkey. It must also be borne in mind that, in accordance with this view, as soon as the tail of the peahen became dangerously long, and its development was consequently checked, she would have continually reacted on her male progeny, and thus have prevented the peacock from acquiring his present magnificent train. We may therefore infer that the length of the tail in the peacock and its shortness in the peahen are the result of the requisite variations in the male having been from the first transmitted to the male offspring alone.

We are led to a nearly similar conclusion with respect to the length of the tail in the various species of pheasants. In the Eared pheasant (*Crossoptilon auritum*) the tail is of equal length in both sexes, namely sixteen or seventeen inches; in the common pheasant it is about twenty inches long in the male and twelve in the female; in Soemmerring's pheasant, thirty-seven inches in the male and only eight in the female; and lastly in Reeve's pheasant it is sometimes actually seventy-two inches long in the male and sixteen in the female. Thus in the several species, the tail of the female differs much in length, irrespectively of that of the male; and this can be accounted

mission to the male sex than by the agency of natural selection, resulting from the length of tail being more or less injurious to the females of these several allied species.

We may now consider Mr Wallace's argu... of ... males would in all, or almost all cases, have been transmitted to the females, unless the transference had been checked through natural selection. I may here remind the reader that various facts opposed to this view have already been given under reptiles, amphibians, fishes and lepidoptera. Mr Wallace rests his ...

very conspicuous manner, the nest is of such a nature as to conceal the sitting bird; but when there is a marked contrast of colour between the sexes, the male being gay and the female dull-coloured, the nest is open and exposes the sitting bird to view. This coincidence, as far as it goes, certainly seems to favour the belief that the females which sit on open nests have been specially modified for the sake of protection; but we shall presently see that there is another and more probable explanation, namely, that conspicuous females have acquired the instinct of building domed nests oftener than dull-coloured birds. Mr Wallace admits that there are, as might have been expected, some exceptions to his two rules, but it is a question whether the exceptions are not so numerous as seriously to invalidate them.

There is in the first place much truth in the

[8] Mr Ramsay, in *Proc. Zoolog. Soc.* 1868, p. 50.

[9] *Journal of Travel*, edited by A. Murray, vol. i, 1868, p. 8.

Duke of Argyll remarks, that a large domed nest is more conspicuous to an enemy, especially to all tree-haunting carnivorous animals, than a smaller open nest. Nor must we forget that with many birds which build open nests, the male sits on the eggs and aids the female in feeding the young: this is the case, for instance, with *Pyranga aestiva*,[28] one of the most splendid birds in the United States, the male being vermilion, and the female light brownish-green. Now if brilliant colours had been extremely dangerous to birds whilst sitting on their open nests, the males in these cases would have suffered greatly. It might, however, be of such paramount importance to the male to be brilliantly coloured, in order to beat his rivals, that this may have more than compensated some additional danger.

Mr. Wallace admits that with the King-crows (Dicrurus), Orioles, and Pittidae, the females are conspicuously coloured, yet build open nests; but he urges that the birds of the first group are highly pugnacious and could defend themselves; that those of the second group take extreme care in concealing their open nests, but this does not invariably hold good; and that with the birds of the third group the females are chiefly coloured brightly on the under surface. Besides these cases, pigeons which are sometimes brightly, and almost always conspicuously coloured, and which are notoriously liable to the attacks of birds of prey, offer a serious exception to the rule, for they almost always build open and exposed nests. In another large family, that of the humming-birds, all the species build open nests, yet with some of the most gorgeous species the sexes are alike; and in the majority, the females, though less brilliant than the males, are brightly coloured. Nor can it be maintained that all female humming-birds, which are brightly coloured, escape detection by their tints being green, for some display on their upper surfaces red, blue, and other colours.

In regard to birds which build in holes or construct domed nests, other advantages, as Mr. Wallace remarks, besides concealment are gained, such as shelter from the rain, greater warmth, and in hot countries protection from the sun;[31] so that it is no valid objection to his view that many birds having both sexes obscurely coloured build concealed nests.[32] The female horn-bill (Buceros), for instance, of India and Africa is protected during incubation with extraordinary care, for she plasters up with her own excrement the orifice of the hole in which she sits on her eggs, leaving only a small orifice through which the male feeds her; she is thus kept a close prisoner during the whole period of incubation;[33] yet female horn-bills are not more conspicuously coloured than many other birds of equal size which build open nests. It is a more serious objection to Mr. Wallace's view, as is admitted by him, that in some few groups the males are brilliantly coloured and the females obscure, and yet the latter hatch their eggs in domed nests. This is the case with the Grallinae of Australia, the superb warblers (Maluridae) of the same country, the sun-birds (Nectariniae), and with several of the Australian honey-suckers or Meliphagidae.[34]

If we look to the birds of England we shall see that there is no close and general relation between the colours of the female and the nature of the nest which is constructed. About forty of our British birds (excluding those of large size which could defend themselves) build in holes in banks, rocks, or trees, or construct domed nests. If we take the colours of the female goldfinch, bullfinch, or blackbird, as a standard of the degree of conspicuousness, which is not highly dangerous to the sitting female, then out of the above forty birds the females of only twelve can be considered as conspicuous to a dangerous degree, the remaining

27 *Journal of Travel*, edited by A. Murray, vol. i, 1868, p. 281.

28 Audubon, *Ornithological Biography*, vol. i, p. 233.

29 Jerdon, *Birds of India*, vol. ii, p. 108. Gould's *Handbook of the Birds of Australia*, vol. i, p. 463.

30 For instance, the female *Eupetomena macroura* has the head and tail dark blue with reddish loins; the female *Lampornis porphyrurus* is blackish-green on the upper surface, with the lores and sides of the throat crimson; the female *Eulampis jugularis* has the top of the head and back green, but the loins and the tail are crimson. Many other instances of highly conspicuous females could be given. See Mr. Gould's magnificent work on this family.

31 Mr. Salvin noticed in Guatemala (*Ibis*, 1864, p. 375) that humming-birds were much more unwilling to leave their nests during very hot weather, when the sun was shining brightly, as if their eggs would be thus injured, than during cool, cloudy, or rainy weather.

32 I may specify, as instances of dull-coloured birds building concealed nests, the species belonging to eight Australian genera described in Gould's *Handbook of the Birds of Australia*, vol. i, pp. 340, 362, 365, 383, 387, 389, 391, 414.

33 Mr. C. Horne, *Proc. Zoolog. Soc.*, 1869, p. 243.

34 On the nidification and colours of these latter species, see Gould's *Handbook of the Birds of Australia*, vol. i, pp. 504, 527.

tion and whilst accompanying her young Hence there is not the least *a priori* improb ability in the development of her tail having been checked through natural selection But the females of various pheasants which apparently are exposed on their open nests to as much danger as the peahen have tails of con siderable length The females as well as the males of the *Menura superba* have long tails, and they build a domed nest which is a great anomaly in so large a bird Naturalists have wondered how the female Menura could man age her tail during incubation but it is now known[8] that she enters the nest head first and then turns round with her tail sometimes over her back but more often bent round by her side Thus in time the tail becomes quite askew and is a tolerable guide to the length of time the bird has been sitting Both sexes of an Australian kingfisher (*Tanysiptera sylvia*) have the middle tail feathers greatly length ened and the female makes her nest in a hole and as I am informed by Mr R. B Sharpe these feathers become much crumpled during incubation

In these two latter cases the great length of the tail feathers must be in some degree incon venient to the female and as in both species the tail feathers of the female are somewhat shorter than those of the male it might be argued that their full developme t l ll t

o dangerously great, she would have retained a much longer tail than she actually possesses for her tail is not nearly so long relatively to the size of her body as that of many female pheasants nor longer than that of the female turkey It must also be borne in mind that in accordance with this view as soon as the tail of the peahen became dangerously long and its development was consequently checked she would have continually reacted on her male progeny and thus have prevented the peacock from acquiring his present magnificent train We may therefore infer that the length of the tail in the peacock and its shortness in the peahen are the result of the requisite variations in the male having been from the first trans mitted to the male offspring alone

We are led to a nearly similar conclusion with respect to the length of the tail in the various species of pheasants. In the Eared pheasant (*Crossoptilon auritum*) the tail is of equal length in both sexes namely sixteen or seventeen inches in the common pheasant it is about twenty inches long in the male and twelve in the female in Sœmmering s pheasant thirty seven inches in the male and only eight in the female and lastly in Reeve s pheasant it is sometimes actually seventy two inches long in the male and sixteen in the female Thus in the several species the tail of the female differs much in length irrespectively of that of the male and this can be accounted for as it seems to me with much more probability by the laws of inheritance —that is by the successive variations having been from the first more or less closely limited in their transmission to the male sex than by the agency of natural selection resulting from the length of tail being more or less injurious to the females of these several allied species

We may now consider Mr Wallace s argu ments in [9]

males would in all or almost all cases, have been transmitted to the females unless the transference had been checked through natural selection I may here remind the reader that various facts opposed to this view have al ready been given under reptiles amphibians, fishes and lepidoptera Mr Wallace rests his belief chiefly but not exclusively as we shall see in the next chapter on the following statement [9] that when both sexes are coloured in a very conspicuous manner the nest is of such a nature as to conceal the sitting bird but when there is a marked contrast of colour between the sexes the male being gay and the female dull-coloured the nest is open and exposes the sitting bird to view This coin cidence as far as it goes certainly seems to favour the belief that the females which sit on open nests have been specially modified for the sake of protection but we shall presently see that there is another and more probable ex planation namely that conspicuous females have acquired the instinct of building domed nests oftener than dull-coloured birds. Mr Wallace admits that there are as might have been expected some exceptions to his two rules, but it is a question whether the exceptions are not so numerous as seriously to invalidate them

There is in the first place much truth in the

[8] Mr Ramsay in *Proc Zoolog Soc.* 1868, p. 50.

[9] *Journal of Travel*, edited by A. Murray vol. i, 1868, p. 78.

n cealed r l ly r r the tal bc ng lull blu bar led th black wl l t tl t of tl f n l is brown w th l lacks l l ars so tl t l r tl e tail d ff s in col r r t tl two e in e actly the me n ann r as tl wl ole i per surface in tl e two sc f C rei t

W tl I r t wl l l k wise bu l l in l l s we f l nal k us cases r r n t f tl pecr s l th se e b ll tly col ured an l in l v t gu l l le l t n t a f w pecr tl e r ales e col ed tl r m re vivilly tl an tl f l e e y d ff r ntly fr t tl r Il l des tl t gly in k l l ff r c e tl wl l u der surface f tl r l k g l ry (l p u r f j l l) sc l t wl f tl f r l s

t usted tl e co cl n s t ting ual selectio t g th r th q ual or nearly eq al al rtan by b tl se l v r di eetl let rim ed tl e man f n d ficat n f wl l g l l

f males. Tl g f t fact f r diff re ces col m t be cco ted f l y gr some f tl t th l l r s f be from tl first l t l n t n mus to w tl sam se as t n lia dly l mai t l l th t th se d ff e pec ally wh v t l ght, serv as prot ct t tl f l t Th all tl pec tl pl l l g p f c th t g l ld l l an l M G ld t g figu f b tl f tw t fi pec s, all f l l w tl part l ep- t n, tl se diff som tim l gl tl so tim l ol —tl n l

Agai in tl g t gro i f tl e wood pe n tl sc s r g n r lly ly al k b t tl M g p al d all tl se parts of tl l ad eck, l b at wl l a e r mso r tl m l a p l ro n in tl e f mal A l wodpeck rs tl t ad f tl n al l right so wl l t tl t f tl e f male tl t occ ed t e tl t thi col n m gl t possl ly n k tl e f l l g m lly co p ul l p t l l ad t f tl l l co taim g l r t d c sequ tly th t tl l accord w tl M W l lace b l f l ad l ee el m ted Tl w t gtl d by wl t M ll b tat w tl pect t l d p s lolt n m ly th t tl f l l k tl y r g m l h

f th pec tl se eq ll l rill t and thus l M W llace l l l l good b t som f th A t l l pec th ol m f tl f m l th l d that th se f tl m l ard i l nd dly-col ed pec tl se d ff m cl tl t

f tl mal is b lted w tl black Ag in Carci t tl d ff ce b twee tl consp tl m l tl ipe rfac d ll bl banded tl black, tl l face tl f ll g co d r t ns d thi be g l rtl f -col ed and tl cl tr m ly d bt f l tl mal tak a f l red also t tl l ad tl f mal th ppe l t r,[a] d w ld b tl alm face is edd h l w l anded tl bl ck r ll posed to l g botl se f mal d th l fac h t w tl bl k n k g It t ting fact as l w g l w tl sam pec l t l f se l col g ft l t rise all ed f rm th t n th pe f D l tl m l l ff rs f m tl f

See h M nog l f th T g d l ted t Nam ly C yanal y n. G uld H ndbook f the B ds f Aust alia, l i, p. 133 see also pp 130 136

ing twenty eight h ... [8] Nor is ... genus ... colour ... sexes and the nature of the nest constructed. Thus the male house sparrow (*Passer domesticus*) differs much from the female; the male tree sparrow (*P. montanus*) hardly at all, and yet both build well-concealed nests. The two sexes of the common fly-catcher (*Muscicapa grisola*) ... and both sexes build in holes or conceal their nests. The female blackbird (*Turdus merula*) differs much, the female ring-ouzel (*T. torquatus*) differs less, and the female common thrush (*T. musicus*) hardly at all from their respective males; yet all build open nests. On the other hand, the not very distantly allied water-ouzel (*Cinclus aquaticus*) builds a domed nest, and the sexes differ about as much as in the ring-ouzel. The black and red grouse (*Tetrao tetrix* and *T. scoticus*) build open nests in equally well concealed spots, but in the one species the sexes differ greatly, and in the other very little.

Notwithstanding the foregoing objections, I cannot doubt, after reading Mr. Wallace's excellent essay, that looking to the birds of the world, a large majority of the species in which the females are conspicuously coloured (and in this case the males with rare exceptions are equally conspicuous) build concealed nests for the sake of protection. Mr. Wallace enumerates [9] a long series of groups in which this rule holds good; but it will suffice here to give, as instances, the more familiar groups of kingfishers, toucans, trogons, puff-birds (Capitonidae), plantain-eaters (Musophagae), woodpeckers and parrots. Mr. Wallace believes that in these groups, as the males gradually acquired through sexual selection their brilliant colours, these were transferred to the females and were not el...

... to this view, their present manner of nesting was acquired before their present colours. But it seems to me much more probable that in most cases, as the females were gradually rendered more and more brilliant from partaking of the colours of the male, they were gradually led to change their instincts (supposing that th...

... Audubon's account of the differences in the nests of the same species in the northern and southern United States, [10] will feel any great difficulty in admitting that birds, either by a change (in the strict sense of the word) of their habits, or through the natural selection of so-called spontaneous variations of instinct, might readily be led to modify their manner of nesting.

This way of viewing the relation, as far as it holds good, between the bright colours of female birds and their manner of nesting, receives some support from certain cases occurring in the Sahara Desert. Here, as in most other deserts, various birds, and many other animals, have had their colours adapted in a wonderful manner to the tints of the surrounding surface. Nevertheless there are, as I am informed by the Rev. Mr. Tristram, some curious exceptions to the rule; thus the male of the *Monticola cyanea* is conspicuous from his bright blue colour, and the female al... equally ... and ... of D... the ... species are far from receiving protection from their colours, yet they are able to survive, for they have acquired the habit of taking refuge from danger in holes or crevices in the rock.

With respect to the above groups in which the females are conspicuously coloured and build concealed nests ... suppose that each ... had its nidifying instinct ... that the early progenitors of ... group were

[8] I have consulted on this subject Mr. ... Brit. Birds ... con... ... Mus. ... Cyp... ... males ... Aleedo and Merops. ... Journal of Travel, edited by A. Murray, vol. i.

[10] ... Ornithological Biography ... Soc. ... 1869 ...

Therefore if oth pecies f G llus and Columba were d mest cated nd aried, it ould ot be rash t pred t th t imilar rules of sexual similarity and diss milarit d pend ing th f rm f transmissi n, w uld hold good in both cases. In like mann r th same form of transmission has g rally pre ailed unde natur thr gh t the same gro ps, al though marked excepti ns t this rule occur Thus thin th sam family o n g nus, the sexes may be id t cally alike, r ry dif ferent in colour In tances ha already been gi en in the sam g s, as w th parr ws, fly catchers, thrush and grouse In th family f pheasants th se es f almost ll the pecies are nderf lly dissim lar ! I are q te alike in th eared pheasant *C os ptilo ri m* In t o species f Chloephaga, g nus f g ese the male cann t be di ti gui hed f m th f h wl I t tw tl rs, th

him more or less complete) Il re protecti n can hardly ha com t play Mr Blyth forms m that th f m les f *Oriol melano-* f m ll ed pecies, wh n uf

prese ts an int rmedi te garb which is ul timat l hanged f th sam li ry as that of th mal So again th f mal *Falco pere-* *g* acquires h bl pluma m re l ly than th mal Mr Swinhoe tates that with on of the dron, hrikes (*Dicrurus macro-* *rr*) th mal whilst almost nestling, moults hi soft b w pl mag and becomes f iform glossy gree h black b t th fe-male reta ns f lo t in th whit striæ and pots th llars f th rs and does t complet l assum th unif rm black col-ou of th mal f three ar Th sam cellent observ remarks that in th pri g f the second year th f m l poo bill (Pl ta. l China resembl th mal f th first ear and that ppare tly t is n t until th

third pri g that l equires tl e sam adult plum ge as that possessed i tl mal t a much earl er ge Il e f nal *B mby lla carol nensis* differs ry littl from th male, i l l k beads f red

male In the mal ol an l u a... a. (*Pal rn a c*) th pper mand ble i l est y uth, but n the fe-

all respects. B th se f t w u l ultimately f rn hed w th tuft f hri tl on wo- -ol t b rds th t ft is

f to n

These cases mu t n t be confounded w th those wh re diseased old f mal al n mall ass m masculin charact rs, n r w th those wh f rtil f males, whilst y u g e q ir th hara t rs f th male thr gh riati or som unkn w cause [a] B t all these cases ha so much in comm n that th y d pe d accordi g t the hypothesis of pan g esis, n g mmules d ri ed f m each part f th mal be g p esent, th gh lat nt, n th f mal th d l pm nt foll wing on som light chang n the electi affinities of h constit nt tiss es.

A f w w rds must be added n hanges f plumag in lati n to th season of th year

[a] Wh th mal courts th f mal these m ts are b ted, d are sh w ff t great d a t th tstret hed w A Le th

[a] The *Ibis* vol vi., 1864 p 122.

ari us instances with La us, Rut cilla, Linaria, d A as Aud bo has l o recorded milar case (*Or tholog Biogr phy* ol. p. 519) with *Pyr g a*.

species have their heads of an equally bright crimson in other peceies the lifference be tween the sexes in the amount of scarlet is so slight that it can hardly make any appreciable difference in the danger incurred and lastly the colouring of the head in the two sexes often differ slightly in other ways

The cases as yet given of slight and gradu ated differences in colour between the males and females in the groups in which as a general rule the sexes resemble each other all relate to species which build domed or concealed nests But similar gradations may likewise be ob served in groups in which the sexes as a general rule resemble each other but which buil l open nests

As I have before instan ... an ... ig ... e ... ie

... nces in plumage between the sexes are of the same general nature as the occasion ally greater differences ... f

... t ... manner in the two sexes Similar cases may be observed with parrots and pigeons The differences in colour between the sexes of the same species are also of the same general nature as the differences in colour between the distinct species of the same group For when in a group in which the sexes are usually alike the male differs considerably from the female he is not coloured in a quite new style Hence we may infer that within the same group the special colours of both sexes when they are alike and the colours of the male when he differs slightly or even consid erably from the female have been in most cases determined by the same general cause this being sexual selection

It is not probable as has already been re marked that differences in colour between the sexes when very slight can be of service to the female as a protection Assuming however that they are of service they might be thought to be cases of transition but we have no reason to believe that many species at any one time are undergoing change Therefore we can hardly admit that the numerous females which differ very slightly in colour from their males are now all commencing to become obscure for the sake of protection Even if we con ... ler somewhat more marked sexual differences, is it probable for instance, that the head of the female chaffinch —the crimson on the breast of the female bullfinch —the green of the fe male greenfinch —the crest of the female golden crested wren have all been rendered less bright by the slow process of selection for the sake of protection? I cannot think so and still less with the slight differences between the sexes of those birds which build concealed nests On the other hand the differences in colour between the sexes whether great or small may to a large extent be explained on the principle of the successive variations, ac quired by the males through sexual selection, having been from the first more or less limited in their transmission to the females. That the degree of limitation should differ in different species of the same group will not surprise any one who has studied ...

As far as I can discover there are few large groups of birds in which all the species have both sexes alike and brilliantly coloured but I hear from Mr Sclater that this appears to be the case with the Musophagae or plantain eaters Nor do I believe that any large group exists in which the sexes of all the species are widely dissimilar in colour Mr Wallace in forms me that the chatt ...

... r ... r ast and th ...

... throughout ... and this from what ... the fluctuating nature of inheritance ... circumstance But that the ... largely prevail with allied animals ... surprising ... fowl has produced a great number of breeds and ... these the sexes generally differ in plumage so that it has been noticed as an unusual cir cumstance when in certain sub breeds they resemble each other On the other hand the domestic pigeon has likewise produced a vast number of distinct breeds and sub breeds and in these with rare exceptions the two sexes are identically alike

[2] Gould 'Handbook of the Birds of Australia' vol i pp 109 149

... 'Variation of Animals and Plants under Domestication,' ...

CHAPTER XVI

BIRDS—*Concluded*

We must now consider the transmission of characters, as limited by age, in reference to sexual selection. The truth and importance of the principle of inheritance at corresponding ages need not here be discussed, as enough has already been said on the subject. Before giving the several rather complex rules or classes of cases, under which the differences in plumage between the young and the old, as far as known to me, may be included, it will be well to make a few preliminary remarks.

With animals of all kinds when the adults differ in colour from the young, and the colours of the latter are not, as far as we can see, of any special service, the ma[y] gen[er]all[y] be [a]ttributed, lik[e] various embryological structures, t[o] the ret[e]ntion of a forme[r] charact[er]. B[u]t this view can be maintained with confidence onl[y] [w]hen the young of se[v]eral [s]pecies resembl[e] each othe[r] closel[y] and lik[e]wise resemble other adult species belonging t[o] the same group; for the latt[er] are the li[v]ing proof that such a stat[e] of things was form[erly] possible. Young lions and p[u]mas are marked with feeble [s]tripes or row[s] of spots, and as man[y] allied species both [y]ou[ng] and [o]ld are similarl[y] marked, [no] belie[ve]r in [ev]ol[u]tion will doubt that the progenitor of th[e] l[ion] and p[u]ma wa[s] [a s]triped animal, and that th[e] [yo]ung ha[ve] retained [ve]stiges of th[e] stripes, lik[e] th[e] kitt[e]ns of black cats, [w]hi[c]h are [n]ot [i]n th[e] l[e]ast [s]triped wh[en] grown [u]p. Man[y] species of dee[r], which when mat[u]re are [n]ot spotted, are whil[s]t [y]oung co[ve]red with [w]hit[e] spots, as are like[w]ise som[e] few speci[es] [in] the ad[u]lt stat[e]. [S]o [a]gain th[e] [y]ou[n]g in th[e] wh[ole] famil[y] of pigs (Sui[d]a[e]), and in ce[r]tai[n] rathe[r] d[is]tantl[y] al[li]ed [a]nimals, ... the t[a]pir are marked with dark longit[u]dinal [s]tripes ... [c]hara[cter] [a]pparentl[y] de[riv]ed from an ext[inc]t prog[eni]tor and n[o]w pres[erved] ... the [y]ou[n]g alon[e] ... [In] ... [su]ch cases the [o]ld ha[ve] [had] th[eir] [c]ol[ours] [c]ha[n]ged ... the co[u]rse [of] t[i]m[e], whilst th[e] [y]oung ha[ve] re[main]ed but [l]ittl[e] [a]lt[e]red; and this has bee[n] [e]ffected throu[g]h th[e] principl[e] [o]f i[nh]eritance [a]t corresp[on]d[i]ng [ages].

Th[is] sam[e] princ[i]pl[e] [a]ppl[ies] t[o] ma[ny] [bi]r[ds] belo[n]g[in]g t[o] [v]ari[ous] gro[u]ps, in [w]h[ic]h [the] [yo]u[n]g [c]losel[y] resembl[e] ... [ea]ch [o]th[er], and di[ff]er m[u]ch from their respecti[ve] adult parents. The young of almost all the Gallinaceæ and of some distantl[y] allied birds such as ostriches, are co[v]ered w[i]th longitudinal[ly] [s]triped [d]own; b[u]t th[is] charact[e]r points back t[o] a state of thin[gs] so remot[e] that it hardl[y] concerns us. Young crossbills (Loxia) ha[v]e [a]t first [s]tra[ig]ht be[a]ks lik[e] those of [o]ther finches, and in their [i]mmature [s]triated plumage they resemble the mature redpole and f[e]male siskin, as w[e]ll as the [y]ou[n]g of the goldfinch, greenfinch, and some other allied species. The [yo]ung of man[y] [k]inds of bu[n]tings (Emberiza) resemble one an[o]th[e]r and lik[e]w[i]se the [a]d[u]lt stat[e] [o]f the common bunting, E. miliaria. In [a]lmost the whole large group of thrushes the [yo]ung ha[ve] the[ir] brea[s]t spotted—a charact[e]r whi[c]h is retained through[-]out lif[e] b[y] man[y] [s]pecies, but [is] qu[i]t[e] lo[s]t [b]y others, as b[y] the Turdus migratorius. So again with man[y] thrushes, the f[ea]th[e]rs on the back are mottled before they are moulted for the first time, and this charact[e]r is retained for lif[e] by certain east[er]n [s]pecies. The you[n]g of man[y] species of shrikes (Lani[us]), of som[e] woodpeck[e]rs, and of an I[n]dian pigeon (Chalc[o]phaps in[-]d[ica]), [a]re tran[s]versel[y] [s]triped on th[e] und[er] ...

no at ... ge[nu]s, Dendroc[y]g[n]a, wh[ic]h [i]n mat[u]re ... [si]m[i]lar ... t[o] w[i]ll h[a]rdl[y] be gi[ve]n in regard to cer[-]tai[n] [gr]o[u]ps. You[ng] bla[c]k gro[u]se (Tetrao t[etrix]) resembl[e] the young as w[e]ll a[s] th[e] old of certain [o]th[er] [s]pec[i]es, for [i]nstance the red gro[u]se or T[etrao] [s]co[ticus] ... [a]s M[r]. Bl[y]th, who has at[-]t[en]ded closel[y] t[o] th[is] [s]ubject, h[as] w[e]ll remarked, th[e] nat[u]ral affinit[i]es of m[any] ... [s]pec[i]e[s] are best [ex]h[ibi]ted [i]n th[eir] [im]mat[u]re plum[a]ge; and

[1] [In] regard t[o] thrush[e]s, shrikes, [an]d [w]oodpeck[e]rs, see M[r]. Bl[y]th, ... worth ... ... vol. ... p. 304 ... his tra[n]slat[ion] of C[uvier's] ... p. 159 ... the case [o]f ... M[r]. Blyth ... form ... thrushes, see ... O[r]th. ... p. 195 ... Chr ... [Blyth] [q]uoted ... ... birds of India, vol. ... p. 485 ... d ... Blyth, Ibis, 1867, p. 1[7]5.

From reasons formerly assigned there can be little doubt that the elegant plumes long pendant feathers crests &c of egrets herons and many other birds which are developed and retained only during the summer serve for ornamental and nuptial purposes though common to both sexes The female is thus rendered more conspicuous during the period of incubation than during the winter but such birds as herons and egrets would be able to defend themselves As however plumes would probably be inconvenient and certainly of no use during the winter it is possible that the habit of moulting twice in the year may have been gradually acquired through natural selection for the sake of casting off inconvenient ornaments during the winter But this view cannot be extended to the many waders whose summer and winter plumages differ very little in colour With defenceless species in which both sexes or the males alone become extremely conspicuous during the breeding season —or when the males acquire at this season such long wing or tail feathers as to impede their flight as with Cosmetornis and Vidua —it certainly at first appears highly probable that the second moult has been gained for the special purpose of throwing off these ornaments We must however remember that many birds such as some of the birds of paradise the Argus pheasant and peacock do not cast their plumes during the winter and it can hardly be maintained that the constitution of these birds at least of the Gallinaceæ renders a double moult impossible for the ptarmigan moults thrice in the year [33] Hence it must be considered as doubtful whether the many species which moult their ornamental plumes or lose their bright colours during the winter have acquired this habit on account of the inconvenience or danger which they would otherwise have suffered

I conclude therefore that the habit of moulting twice in the year was in most or all cases first acquired for some distinct purpose perhaps for gaining a warmer winter covering and that variations in the plumage occurring during the summer were accumulated through sexual selection and transmitted to the offspring at the same season of the year that such variations were inherited either by both sexes or by the males alone according to the form of inheritance which prevailed This appears more probable than that the species in all cases originally tended to retain their ornamental plumage during the winter but were saved from this through natural selection resulting from the inconvenience or danger thus caused

I have endeavoured in this chapter to shew that the arguments are not trustworthy in favour of the view that weapons bright colours and various ornaments, are now confined to the males owing to the conversion by natural selection of the equal transmission of characters to both sexes into transmission to the male sex alone It is also doubtful whether the colours of many female birds are due to the preservation for the sake of protection of variations which were from the first limited in their transmission to the female sex But it will

[33] See Gould's *Birds of Great Britain.*

the young and old

p co cerned is

hib ted till m re learly a certain anomalou f case thus the mal of *H liothrix a l ta* (on f th humming b rd) diff rs con p cu ou ly fr m th f mal n ha g a pl did g re t and fin ar t fts, b t th fem le is re m h p much l g r t d than

l

th respects, incl di g th bl so that tl tail f th mal ctually b co h rt as h caches m tur ty which is most un al circumstance Again th pl mag of l A (Merg m g user) s

f thers m occurs, as far I kn w in any th b rd, tl crest f th d lt mal th gh l roa l tl n tl f m l cons l rabl l rt be tr

lo g s u semil tl d lt f mal so th t tl r est are t ll f gre t r l gtl tl gh na row tl an in th ad lt mal

Wl th y g and tl f m les l sely re sem l tl d botl diff from th ma ma an

t l l l na x uas

dist t co tri For w n se r prese tat e pecies th ad lt males h e und g ne a erta n am nt of cl ge and can be d tinguished the f males and the yo g f om tl distinct countri be ng nd ting ish able and theref re bsol tely unchanged Th the case with certain Indian chats (Thamn b) w th certain h n y k rs (Nectarinia) hrik s (Tephrodornis) certain ki gfi h (Tanysiptera) K l j ph asa ts (G ll phasi) and tree part dges (Arboricol)

I som an l g u cases, mely w th b rds ha g d ffere t umm r d w nt r pl m g b t w th tl e t o se s n arly al k cer ta l sely ll ed pecie can as ly be d ti gui hed in th s mm r pl al j l m g y t are nd t g isl able n tl w nte a w ll as in tl mm ture pl g Tl tl case w th som f th l sely ll l Ind an w g ta ls M t ca ille M s hoe ni rm e t tree pec es f A leola, gen of l r

bl tl ad lt tl w t tress. his case is all th m re t re t g l ce se w tl two th spec f Ardeola botl se s ta n, d p tl w t and mm n arly tl e sam

bee partially l t by th ad lt m l f m som explai ed ca se and tran tted n their liminished tat to th m l ff j n g alo h arri ed t th corre po d g g f mat rit Th belief th t n th p se t lass th mal al has bee mod fied, as f as tl diff ces between th m l and tl f male

seasons, p to f th g re col red In all th se cases, th n pt l pl m g wl l w m as m was rigi lly acq red b tl ad lt mal d ring th breedin ason, and t ans m tted to th ad lts f b th se t th co po ding seaso has been mod fied wh lst tl w t and mm t plum g h been l ft h ged.

less b lha tl coloured l som species of cel the les ha blue tails, d the f males bro urs d M R. B Sharpe f rms m that th tail f tl ung mal f *D g ud howd* is t first bro M G uld has described (*bid* l. pp 14 & 37) th se es d th y g of certa bla k cockatoos d of th ki g lory th whi h th same rule prevails. Also J rd (*B ds f I dia*, l p 260) the *Palaeorn* osa hich the y g m re l ke th f mal than th mal See Aud bo (*O hologi al Biogr phy* l p 4) th tw se es nd the y g of *Col mba passeri*

I this nformatio t M G uld h he ed e be pecim ns see lso h *Introduction to th Trochilidæ* 1861 p. 120

Macgillivray *Hist. Brit. B ds* l. pp 207 214

Mr Blyth, in *Ibis* January 1861 p 25

as the true affinities of all organic beings depend on their descent from a common progenitor this remark strongly confirms the belief that the immature plumage approximately shews us the former or ancestral condition of the species

Although many young birds belonging to various families thus give us a glimpse of the plumage of their remote progenitors yet there are many other birds, both dull coloured and bright-coloured in which the young closely resemble their parents In such cases the young of the different species cannot resemble each other more closely than do th[illegible] nor [illegible] ien [illegible] he [illegible] in so far that when the young and the old are coloured in the same general manner throughout a whole group of species it is probable that their progenitors were similarly coloured

We may now consider the classes of cases under which the differences and resemblances between the plumage of the young and the old in both sexes or in one sex alone may be grouped Rules of this kind were first enounced by Cuvier but with the progress of knowledge they require some modification and amplification This I have attempted to do as far as the extreme complexity of the subject permits from information derived from various sources but a full essay on this subject by some competent ornithologist is much needed In order to ascertain to what extent each rule prevails, I have tabulated the facts given in four great works namely by Macgillivray on the birds of Britain Audubon on those of North America, Jerdon on those of India and Gould on those of Australia I may here premise first that the several cases or rules graduate into each other and secondly that when the young are said to resemble their parents it is not meant that they are identically alike for their colours are almost always less vivid and the feathers are softer and often of a different shape

Rules or Classes of Cases

I When the adult male is more beautiful or conspicuous than the adult female the young of both sexes in their first plumage closely resemble the adult female as with the common fowl and peacock or as occasionally occurs they resemble her much more closely than they do the adult male

II When the adult female is more conspicuous than the adult male as sometimes though rarely occurs the young of both sexes in their first plumage resemble the adult male

III When the adult male resembles the adult female the young of both sexes have a peculiar first plumage of their own as with the robin

IV When the adult male resembles the adult female the young of both sexes in their first plumage resemble the adults, as with the kingfisher many parrots, crows hedge-warblers

V When the adults of both sexes have a distinct winter and summer plumage whether or not the male differs from the female the young resemble the adults of both sexes in their winter dress or much more rarely in their summer dress or they resemble the females alone Or the young may have an intermediate character or again they may differ greatly from the adults in both their seasonal plumages.

VI In some few cases the young in their first plumage differ from each other according to sex the young males resembling more or less closely the adult males and the young females more or less closely the adult females.

Class I In this class the young of both sexes more or less closely resemble the adult female whilst the adult male differs from the adult female often in the most conspicuous manner Innumerable instances in all Orders could be given it will suffice to call to mind the common pheasant duck and house sparrow The cases under this class graduate into others. Thus the two sexes when adult may differ so slightly and the young so slightly from the adults that it is doubtful whether such cas[illegible] ever are few or at least are not strongly pronounced in comparison with those which come strictly under the present class

The force of the present law is well shewn in those groups in which as a general rule the two sexes and the young are all alike for when in these groups the male does differ from the female as with certain parrots, kingfishers, pigeons &c the young of both sexes resemble the adult female We see the same fact ex

See f[illegible] r[illegible] ist[illegible] ce Mr Gould's acco[illegible] t (*H*[illegible] *ndbook* *f th B*[illegible] *d* *f* [illegible] *t al*[illegible] [illegible] p 133) of Cyanalcyon [illegible] ([illegible] f th[illegible] k[illegible] gf[illegible] h rs) [illegible] n wh[illegible] h [illegible] r th[illegible] y[illegible] g male th[illegible] gh resembl[illegible] g th[illegible] adult female is

ther ch fly n tl points in wh ch they We m urt lly r emble th r e pectiv mal s and fd ti c col ur f tl m le m y af ly be ttr b tl e plu ted to se u l selecti n W th ma v g ll nace l tl tr tl x s d ff r t an tre de

col t f red mu u ly tl th e) l as a t w marks f early t o

mark l e b ast b g mall an m l ld t k y ly i h col u s b ng m ch d ll In th a f ul tl t se m h l l Tl imp b b l

gou ase fo n ne l u e spe partr dg s, q ls, gu fowls, &c in wh ch tl e col ur f th pl m g l e been largely t ansf r ed from tl e m le to th f m l are brill tly ll x mpl fied w th tl e lly so b t w tl (C p tl se e col u ar d ll, m y th t if any part f th pl mag n tl e mal s f th se tw pl asa t l ad bee brill antly col red it n uld n tl e b n transf rred to tl e f males. These fact t gly upport Mr Wallace w th t w th b rds wl cl are x posed to m h dang d ring cubat n the t sf f brigl t col r from the male to tl f m l l een cl ecked through n tu al selec an

tl t an f ce f hu act f m t tl f m l l as bee ffected ppar tly t mod th m l l g b q tly

m pe ed w ld l been po d to m cl dang and w uld g ally h e been d t y d th ld and m c t ou m l s tl tl l and if tl y n d in l h m

g se has acq ed h fin black pl m g th h f ked and t ardly-c led t l f tl b t f th se l t th e l as l ardly bee any t an f ce to tl f mal cepting tl t sl b b ta l t ace f tl urved f k

M g ll y H tory of British B d l. pp. 172-174

t ts w ld n t h b n t an m tted to tl f m l On th th hand m nts f a l co p u kind h as tl p sse ed by tl e E ed and Ch pheasa ts w ld n t h bee dang rous, and if th y ppe red du g arly y th w uld g ally h e been t mitted to b tl

In add t n t th ffects of the part l

The question naturally arises, how is it that in these latter cases the winter plumage of both sexes, and in the former cases the plumage of the adult females, as well as the immature plumage of the young, have not been at all affected. The species which represent each other in distinct countries will almost always have been exposed to somewhat different conditions, but we can hardly attribute to this action the modification of the plumage in the males alone, seeing that the females and the young, though similarly exposed, have not been affected. Hardly any fact shews us more clearly how subordinate in importance is the direct action of the conditions of life, in comparison with the accumulation through selection of indefinite variation, than the surprising difference between the sexes of many birds; for both will have consumed the same food and have been exposed to the same climate.

in the whole family of the Gallinaceæ the females, for instance, of the common and Japan pheasant, and especially of the gold and Amherst pheasant—of the silver pheasant and the wild fowl—resemble one another very closely in colour, whilst the males differ to an extraordinary degree. So it is with the females of most of the Cotingidæ, Fringillidæ, and many other families. There can indeed be no doubt that, as a general rule, the females have been less modified than the males. Some few birds, however, offer a singular and inexplicable exception; thus the females of *Paradisea apoda* and *P. papuana* differ from each other more than do their respective males;[1] the female of the latter species having the under surface pure white, whilst the female *P. apoda* is deep brown beneath. So, again, as I hear from Pro-

both sexes, or from their constitutional differences chiefly on one sex. We see only that this is subordinate in importance to the accumulated results of selection. Judging, however, from a wide-spread analogy, when a species migrates into a new country (and this must precede the formation of representative species), the changed conditions to which they will almost always have been exposed will cause them to undergo a certain amount of fluctuating variability. In this case sexual selection, which depends on an element liable to change—the taste or admiration of the female—will have had new shades of colour or other differences to act on and accumulate; and as sexual selection is always at work, it would (from what we know of the results on domestic animals of man's unintentional selection), be surprising if animals inhabiting separate districts, which can never cross and thus blend their newly-acquired characters, were not, after a sufficient lapse of time, differently modified. These remarks likewise apply to the nuptial or summer plumage, whether confined to the male, or common to both sexes.

Although the females of the above closely allied or representative species, together with their young, differ hardly at all from one another, so that the males alone can be distinguished, yet the females of most species within the same genus obviously differ from each other. The differences, however, are rarely as great as between the males. We see this clearly

pears to have partially retained an immature condition of plumage, for at first sight she might be taken for the young of the Mauritian species. These differences may be compared with those inexplicable ones, which occur independently of man's selection in certain sub-breeds of the game-fowl, in which the females are very different, whilst the males can hardly be distinguished.

As I account so largely by sexual selection for the differences between the males of allied species, how can the differences between the females be accounted for in all ordinary cases? We need not here consider the species which belong to distinct genera; for with these adaptation to different habits of life, and other agencies, will have come into play. In regard to the differences between the females within the same genus, it appears to me almost certain, after looking through various large groups, that the chief agent has been the greater or less transference to the female of the characters acquired by the males through sexual selection. In the several British finches, the two sexes differ either very slightly or considerably; and [illegible] [illegible]

1. Wallace, 'The Malay Archipelago,' vol. ii. 1869, p. 394.

2. These [illegible] described with coloured figures by M. F. Pollen, in 'Ibis,' 1866, p. 27[illegible].

3. 'Variation [illegible] of Animals and Plants under Domestication,' vol. i. p. 251.

ted to se al selectı n. w . . . pe th se es diff t an trem de- gree whilst tal r from th se . . . dim co dit n, and chı fly n tl . . . spl ndid ocelli f th r m l Tl f m le par tridg diff rs from th male ly n th red mark n h breast b g mall and tl fe- m l wild t k y nly h r colo be g m ch d ll In th gui f nl th t se e re di tingu habl Th re n mp b b l ty m the plain, th gh pec l arly potted p h l tl b rd h ing been ac q

th f mal has bee . . . ne of th mal h ing ubseq ntly

g use l as acquired his fi black pl mag th h f ked and twardly-cu led tail f th rs b t f tl se h act rs th has l ardly bee any transf re ce t th f mal cepting th t sh l w k tail trace f th urved f k.

Macgillivray History of British B d ol. i, pp. 172-174

act rs acq red by th mal u l selectı n both during f rmer and recent times. B t it l serve pec al tt nti n th t brill ant col u ha bee transf rred much m re rare- ly than tl t ts For i tance tl e male of th red throat d bl e br ast (Cyanec la succi-) has a rich bl e breast, in l d g a s b- triangular red mark ow marks f n arly tl sam shape ha been tran f rred to the fe- mal but the ce t al pace is ful ou inst ad f red and i urro nded by m ttled n tead f bl fe th r Th Gali naceæ off r m y anal u ases f n e f tl pecı s, uch as p trıdg s, q ails, gu n a fowls, & in wh ch tl col ur f th pl ma have been larg ly t ansf rred from tl e male t the female are brill ntly col red Th s w ll emplified w th th pl easants, n which th mal is g n ally so m ch m e b illiant than th f mal b t w tl th Eared and Cheer pheasants (C os pt lon rıt m and I has s wall ch) th se l sel resembl each oth r a d th ir colo rs are d ll W m y g so far as t bel e e th t if any part f th plum ge in tl e males of th se tw pl asants had been brill antly col ured, t w uld n th been t ansf rred to the f males. Th se fact st gly support Mr. Wallace w th t with b rds which are x posed to much dan r d ring ne b t n, the transf e ce of brıgl t col ur from tl e male to th f mal has been checked through natu al h f g t that

dang and w ld g ne ally h been d troyed th ld and m re h males, n tl tl hand if th y rred in a like mann

tints w ld n t ha n transm tted to th f m les On the the hand o nam ts f a less consp u us kind uch as th se po sessed by tl Eared and Chee ph asa ts, w ld n t h bee dang ro s, and if th y ppeared dur g arly y th, w uld g nerally ha e been transmitted to b th se

In additı n to th effects of the partial

tran ference of characters from the males to the females some of the differences between the females of closely allied pecies may be attributed to the direct or definite action of the conditions of life [1] With the males any such action would generally have been maske l by the brilliant colours gained through sexual se lection but not so with the females Each of the endless diversities in plumage which we see in our domesticated birds is of course the result of some definite cause and under na tural ana more uniform conditions some one tint assuming that it was in no way injurious would almost cert n l

change of colour thus in duce l uniform in character

No one doubts that both sexes of many birds have had their colours adapted for the sake of protection and it is possible that the females alone of some pecies may have been modified for this end Although it would be a difficult perhaps an impossible process as shewn in the last chapter to convert one form of transmission into another through selection there would not be the least difficulty in adapt ing the colours of the female independently of those of the male to surrounding objects through the accumulation of variations which were from the first limited in their transmis sion to the female sex If the variations were not thus limited the bright tints of the male would be deteriorated or destroyed Whether the females alone of many species have been thus pecially modified is at present very doubtful I wish I could f ll

to the female as a protection woul l be at once obliterated instead of being lost simply by not being elected or from free in tercros ing or from b ing eliminated when transferred to the male and in any way injuri ous to him Tl us the plumage of tl e female would be kept constant in char cter It would also be a relief if we could admit that tl e ob scure tints of both sexe of many bird had been acquired and pr served for tl sake of protection —for example of tl e hedg wa bler or kitty wren (*Accentor modularis* and *Troglodytes vulgaris*) with respect to wl i l we have no sufficient evidence of tl e action of sexual selection We ought however to b cau tious in concluding that colours which appear to us dull are not attractive to the females of cer tain species we hould bear in mind such cases as that of the common house sparrow in which the male differs much from the female but does not exhibit any bright tints. No one prob ably will dispute that many gallinaceous l irds which live on the open ground have acquired their present colour at least in part for the sake of protection We know how well they are thus concealed we know that ptarmigans, whilst changing from their winter to their sum mer plumage both of which are protective suffer greatly from birds of prey But can we believe that the very slight differences in tints and markings between for instance the female black grou e an l red grouse serve as a protec tion Are partridges as they are now coloured better protected than if they had resembled quails? Do the slight differences between the females of the common pheasant the Japan and gold pheasants serve as a protection or might not their plumage have been inter cl anged with impunity From h

tences are beneficial For myself I will only say that I am not convinced

Formerly when I was inclined to lay much stress on protection as accounting f r the dull er colours of female bird it occurr l to me that pos ibly both exes an l tl e young might aboriginally have been e qually bright colo ur ed but that sub e quently the females from the danger incurred during incubation an l the young from being inexperienced had been ren dered dull as a protection But this vi w is not supported by any evidence and is not prob able for we thus in imagination expose during past times the f male an l the young to dan ger from w l ich it has sul se quently been nec essary to l ld th ir modified lescen l nt We l av

On tl upposit n tl at tl e females and the young l a e partak n luring eacl stage of th proce of m l f ation of a ten l ncy to l e as brightly colour l as tl males, it is also a som wl at trang fa t tl t the f male l ave n v r been ren l re l dull coloured without tl young part pat ng in tl sam cl ange for tl re are no n tance as far as I can liscov r f pec w th tl e fe mal s dull and the young bright colour l

[1] See on this l ject ch p x tl l ation f A mals nd Pl nts nder Dom tication.

partial e ception how r ff red by tl e y ung f certain woodpeck rs, f th ha e tl whol upper part f the l ead tinged th ed luch afterward tl r decreases int mere circul r red l n n tl ad lts of both sex s, r qu t d sapp n tl ead lt f

mal t the l t period l ta bee reser ed and tl t m t ll f tl se an t m t the l t p riod f l f t h h tl y appeared h been from the first transmitted ly t th ad lt m l ff pring An n t brightn occ rr g in the f mal th g w ld h b f o se ce t tl m nd w ld t l bee se-lected and m reo f dang ro s, w ld h b l min ted Th th f mal and th y g will th l bee l ft mod fied (as m ch m re comm) w ll l bee part ally mod fied by rece g tl ro gh tran.f re ce f m tl mal som f l res n t B th ha ll l ps

m m
fied will t t xhib t l ffects. Tl ese h g and all tl w ll l bee k pt if m by th f t re s f m v nd d ls I so cas pec lly w th g d b rd th f males an l tl g m y poss l l ha bee mod fed d pe d tl f tl m l s, f th sak f p tect so a t l acquired th m l ll-col ed pl

Cl. II If he the ad lt fem l m con p th the adult male th y g f both the fi t pl m y emble the adult male —Thi class actl tl rs f tl last f th f mal are h re bright col ed m consp uo than tl l d tl g, as far as th ar kn esembl tl ad lt m l t d f th ad lt f m l B t tl l ff re ce l twee tl l so gre t as w th many b rd m th first clas f tl ase re compar t l M Wall ce l first lled tt t t th g la rel t n in l xi ts betwee th l ss l g lt col rs f tl m l and th pe f rm g tl d t f incub t l gr t t ss

on tl is point as a c uc l te t that obsc re col rs l l een acq ired f r tl e sake of protection d ring the pe od f r t g l d ff r e t ew see to me n o e prol able ls tl e ase are rious and n t nu rous, I w ll l n fl g e ll th t l l bee al l t f d ll secti n f tl e g n Turn x qu l l t tl f le is invariably larg r than

m
r g i k g -cocks. t mal bird re xposed by tl E gl l b rd-cat l fo a decoy ca t p rd to tch tl r m l by e t ing tl n l v so tl f mal s of this T rnix ar pl cd t l d a Wl n thu e posed tl e f m le soo b gi tl e l d p rri g ll wl l an b h ard l w ff i l any fe-m l w tl l t run y dly to tl pot and comm ce fighting w th th caged b rd In thi w y from tw l e to tw nty b rd all breed f males m y b caught tl cours of a ingle d y Tl nat es assert that the f m l aft l y g th e ggs assoc t in flocks and lea tl m les to sit th m Tl re s n

th ad lt mal

Tl f m l f th tl re pec l pai ted sn pe (Rl yn hœa, fig 6) are n t nly larg b t m h m re ri hl col ured than tl e m l W tl all th b rd n l h the track d ff rs m t t re tl tw se es t m re d l ped and compl th m l th m tl f mal b t n th l h, ha s

Aud bon, Ornith. B og phy l p 193 Macgilli ray History f Brit h B ds l p 85 See also th case bef re gi of Ind p cu ca lotta.

W tm nster Review Jul 1867 and A Murray J nal f T l, 1868 p 83

F th A tral pec see G uld H nd book d l pp 1 8, 180 186 d 188 I th Brit h Museum pecim ns f th Aust al pl d (E dionom t q t) m y b see

transference of characters from the males to the females some of the differences between the females of closely allied species may be attributed to the direct or definite action of the conditions of life [11] With the males any such action would generally have been masked by the brilliant colours gained through sexual selection but not so with the females Each of the endless diversities in plumage which we see in our domesticated birds is of course the result of some definite cause and under natural and more uniform conditions some one tint assuming that it was in no way injurious would almost certainly sooner or later prevail The free intercrossing of the many individuals belonging to the same species would ultimately tend to make any change of colour thus induced uniform in character

No one doubts that both sexes of many birds have had their colours adapted for the sake of protection and it is possible that the females alone of some species may have been modified for this end Although it would be a difficult perhaps an impossible process as shewn in the last chapt ne form lection adapt ing colours of the female independently of those of the male to surrounding objects through the accumulation of variations which were from the first limited in their transmission to the female sex If the variations were not thus limited the bright tints of the male would be deteriorated or destroyed Whether the females alone of many species have been thus specially modified is at present very doubtful I wish I could follow M

... o the female as a protection would be at once obliterated instead of being lost simply by not being selected or from free intercrossing or from being eliminated when transferred to the male and in any way injurious to him Thus the plumage of the female would be kept constant in character It would also be a relief if we could admit that the obscure tints of both sexes of many birds had been acquired and preserved for the sake of protection —for example of the hedge warbler or kitty wren (*Accentor modularis* and *Troglodytes vulgaris*) with respect to which we have no sufficient evidence of the action of sexual selection We ought however to be cau

... nd such cases ... narrow in which the male differs much from the female but does not exhibit any bright tints No one probably will dispute that many gallinaceous birds which live on the ...

... are ... concealed we know that ptarmigans, whilst changing from their winter to their summer plumage both of which are protective suffer greatly from birds of prey But can we believe that the very slight differences in tints and markings between for instance the female black grouse and red grouse serve as a protection Are partridges as they are now coloured better protected than if they had resembled quails? Do the slight differences between the females of the common pheasant the Japan and gold pheasants serve as a protection or might not their plumages have been interchanged with impunity From ...

... ences are beneficial For myself I will only say that I am not convinced

Formerly when I was inclined to lay much stress on protection as accounting for the duller colours of female birds it occurred to me that possibly both sexes and the young might aboriginally have been equally bright coloured but that subsequently the females from the danger incurred during incubation and the young from being inexperienced had been rendered dull as a protection But this view is not supported by any evidence and is not probable for we thus in imagination expose during past times the females and the young to danger from which it has subsequently been necessary to shield their modified descendants. We have also to reduce through a gradual process of selection the females and the young to almost exactly the same tints and markings, and to transmit them to the corresponding sex and period of life On the supposition that the females and the young have partaken during each stage of the process of ... tendency to ... as brightly coloured as the males, it is also a ... what strange fact that the females have never been ... dull coloured without the young participating in the same change for there are no instances as far as I can discover of species with the females dull and the young bright ...

[11] See on this subject ... th ... f ... males and ... under Domestication.

have not been able to disco er wh th r with tese species th oun re-semble th ad lt males more closely than th ad lt f males for the compariso is some hat difficult to make on account [redacted] th double m ult.

Turning now t th ostrich Ord th male of the comm cassowary (*Cas arius galeatus*) would be thought by an n to be the f mal from his smalle size and from th ppendages and naked skin about hi head being much l ss brightl coloured and I am inf rmed b M F t t tl t tl Zoological Gard ns, t is

with more tro gly contrasted colours ne e th less he undertakes tl e whole duty of incu bation.[34]

I will specif the few oth cases kn wn to me in which th f male is more conspicuou l coloured than the mal alth gh notl g is kn wn abo t tl e mann r of ncubati Witl th carrio ha k of the Falkland I land (*Milvag le curus*) I was much surprised to find by dissection that the indi iduals, which had all their tints trongly pronounced w tl ll cere and legs ange-coloured w re the ad lt f males whil t those w th d lk r pl m ge and grey l gs were th mal s or tl e o ng In an Australian tree-creeper (*Cl macteris ery-th ps*) th f mal diff rs from the mal in be-ing adorned w th be tif l, radiated ruf marks on th throat, the male ha ing this part q t plain" Lastl an A tral an night jar the f male alwa xceeds th male in ize and tl brilliance [redacted] her tints the males, n the otl hand ha e two wait spots on tl primaries m re conspicuous than in tl f male"

male of one of the mus (*Dromeu rorat*) is consid rabl lar e than the male and she possesses light top-knot b t is th rwise in distinguishable in pl mag Sh ppears, how eve to ha greater powe whe angry or otherwise excited of recting like turkey cock, the f ath rs of her neck and breast. She is usual th more courageou and p gn tic. The makes deep hollow guttural boom espe ciall at night, soundin lik smal g n. Th male has slenderer fram and is more docil

We thus see that the case in which f male birds are more co spicu usly coloured than th males, w th tl ou g in thei immature pl mage resembling the adult males i t ad of the adult femal s, as in tl previous class, are not n m ro s, though the are distrib t d n an Ord [redacted] The am unt of diff re ce also,

the young from them moth f as soon as she catches sight of h proge he becom iolentl gitated and not th tand g th resistance of th fath ppears to use he t most ndea urs t destro th m Fo mo th afterwards t is unsaf t p t th parents to-gether viole t quarrel being tl ine tabl result in hich th f mal g n rall comes ff conquero "[35] so that with this m w ha compl et re ersal not nl of the parent l and incubating instincts, b t f the us [redacted] moral qualities of the tw se es th f males bein sa age quarrelsome and nois th males gen tle and good The case ery different with the African strich, f the mal is somewhat larger than th f male and has fine p umes

M Scl ter the ncubatio of the Struthiones,

[34] The nati es of Ceram (Wallace *Malay Archi-pelago*, vol ii., p. 1 0) assert that the male d fe-male sit al ernately th eggs but this assertion, as M Bartlett thinks, ma be accounted for by the female isiting the nest t lay her egg

The Times, April, 18 0 p. 124.

[35] See the e account of the habits of this bird under confinement, b M A. W Bennett, in *Land and Water* May 1868, p. 233.

what d her back is redder tha that of the male the head of the male is of rich dark bronzed colour d his back is clothed th finely pe cilled slate-coloured feathers, so that wh ther he may be con-sidered as the more be tiful of the t o. H is larger and more pugnacious tha the female, and does ot sit the eggs. so that ll these respects this pe-cies comes under our first lass of cases b t Mr Sclater (*Proc ed g of the Zoological Society* 1866 p. 150) was much surprised to observ that the you g of both sexes, when abo t three mo ths ld, re-sembled in their dark heads nd necks th adult males, instead of the adult females so that t would ppear in this case that the f males ha been modi fied, whilst the males and the young have retained former state of pl mage.

FIG. 62. Rhynchaea capensis (from Brehm).

tralis it is simple in the male, whilst in the female it makes four distinct convolutions before entering the lungs.[17] The female therefore of this species has acquired an eminently masculine character. Mr. Blyth ascertained by examining many specimens that the trachea is not convoluted in either sex of *R. bengalensis*, which species resembles *R. australis* so closely that it can hardly be distinguished except by its shorter toes. This fact is another striking instance of the law that secondary sexual characters are often widely different in closely allied forms, though it is a very rare circumstance when such differences relate to the female sex. The young of both sexes of *R. bengalensis* in their first plumage are said to resemble the mature male.[18] There is also reason to believe that the male undertakes the duty of incubation, for Mr. Swinhoe[19] found the females before the close of the summer associated in flocks, as occurs with the females of the Turnix.

The females of *Phalaropus fulicarius* and

is far from conspicuous. According to Professor Steenstrup, the male alone of *P. fulicarius* undertakes the duty of incubation; this is likewise shewn by the state of his breast feathers during the breeding season. The female of the dotterel plover (*Eudromias morinellus*) is larger than the male, and has the red and black tints on the lower surface, the white crescent on the breast, and the stripes over the eyes, more strongly pronounced. The male also takes at least a share in hatching the eggs; but the female likewise attends to the young.[20] I

17 Gould's *Handbook of the Birds of Australia*, vol. ii. p. 275.

18 *The Indian Field*, Sept. 1858, p. 3.

19 *Ibis*, 1866, p. 298.

20 For ... *Birds* ... that the ... serve ... of the ... la g ... they ... is, as I ... form ... the *Eudromias* ... are ... less ... larger and have more strongly contrasted colours than the males.

brown — e tige prob bly of f rmer t t ... of the pl mag Freq tly in tl me g o p ... f h nd e en with n tl m ge s f

th cces. al ns first ppeared th m les aft th ... h lst

cases th har ters th us cq red ... bee t ns- m tted t b th se es d ll ges. B t these char- act rs if quired by th m les ... ha bee tr nsm tted t first t th d lts ... e, ... d t som bseq t p riod t n f rred t th y g F t k that, ... th law of in- h rits t corre p d g ges f ... offspring oft h t cha act rs t ... that t h h th y fir t ppe red th p re ts. ... Cas pp re tly of this k d ha bee bsers d w th b rd ... ture ... M. Blyth h see pec m ns f La ... C l ... which h d as umed ...

ase f three g rous y g birds, t f brood of

b t in th ... tl y g d ff r so m l f m tl p nts th t th y f m ly d sc b d d t t pec

I may mark b f proceed g tl t u d r h t d ext t las e f ases tl

f m l d th y g lt is, l poss bl th t th m les y l lected th m ttra t

It m y b ... h l t llust t tl thr modes by h h, th p es t lass, th t se l th y g m y ha com t resembl

... d bl process f select ... lik b l k ly t occur g t th gr t g as of se th th th d heth t uld b m re ffi t th select d l It ther f th most prob bl w th t se al select h ted th p ese t class, as f as m t l ch ra t co ce ed accord ce th th g ul thro gh t the m l k gd m th t is, th m les d that these ha t m tted th grad ually cquired col ur th equally lm t equally t th ff p g f both se

A th po t is m d btful, m ly h th

Jerd B d f Ind l. pp 222, 228 Gould H ndbook to the B ds f A st alia, l. pp 124 130

C uld, ibid., l. pp 37 46 6

A d bo Ornith B og phy l. ii., p. 55

... ri tio f A mals nd Pl nts nder D m st at on, l. p 79

Cha lesworth M gazine f N t ral History

(Cygn lor)

I am ind bted to M Blyth f f rm ti regard t this g us. Th sp rr w f l alestu be- l gs t th b-g us P tr nia.

between the sexes is incomparably less than that which frequently occurs in the last class; so that the cause of the difference, whatever it may have been, has here acted on the females either less energetically or less persistently than on the males in the last class. Mr. Wallace believes that the males have had their colours rendered less conspicuous for the sake of protection during the period of incubation; but the difference between the sexes in hardly any of the foregoing cases appears sufficiently great for this view to be safely accepted. In some of the cases, the brighter tints of the female are almost confined to the lower surface, and the males, if thus coloured, would not have been exposed to danger whilst sitting on the eggs. It should also be borne in mind that the males are not only in a slight degree less conspicuously coloured than the females, but are smaller and weaker. They have, moreover, not only acquired the maternal instinct of incubation, but are less pugnacious and vociferous than the females, and in one instance have simpler vocal organs. Thus an almost complete transposition of the instincts, habits, disposition, colour, size, and of some points of structure, has been effected between the two sexes.

Now if we might assume that the males in the present class have lost some of that ardour which is usual to their sex, so that they no longer search eagerly for the females; or, if we might assume that the females have become much more numerous than the males—and in the case of one Indian Turnix the females are said to be "much more commonly met with than the males"*—then it is not improbable that the females would have been led to court the males, instead of being courted by them. This indeed is the case to a certain extent with some birds, as we have seen with the pea-hen, wild turkey, and certain kinds of grouse. Taking as our guide the habits of most male birds, the greater size and strength as well as the extraordinary pugnacity of the females of the Turnix and emu, must mean that they endeavour to drive away rival females, in order to gain possession of the male; and on this view all the facts become clear; for the males would probably be most charmed or excited by the females which were the most attractive to them by their bright colours, other ornaments, or vocal powers. Sexual selection would then do its work, steadily adding to the attractions of the females; the males and the young being left not at all, or but little modified.

*Jerdon, 'Birds of India,' vol. iii. p. 598.

CLASS III. *When the adult male resembles the adult female, the young of both sexes have a peculiar first plumage of their own.*—In this class the sexes when adult resemble each other, and differ from the young. [illegible] occur with [illegible] can [illegible] female, but [illegible] their mot[illegible] The male [illegible] of the splendid scarlet ibis are alike, whilst the young are brown; and the scarlet colour, though common to both sexes, is apparently a sexual character, for it is not well developed in either sex under confinement; and a loss of colour often occurs with brilliant males when they are confined. With many species of herons the young differ greatly from the adults; and the summer plumage of the latter, though common to both sexes, clearly has a nuptial character. Young swans are slate-coloured, whilst the mature birds are pure white; but it would be superfluous to give additional instances. These differences between the young and the old apparently depend, as in the last two classes, on the young having retained a former or ancient state of plumage, whilst the old of both sexes have acquired a new one. When the adults are bright-coloured, we may conclude from the remarks just made in relation to the scarlet ibis and to many herons, and from the analogy of the species in the first class, that such colours have been acquired through sexual selection by the nearly mature males; but that, differently from what occurs in the first two classes, the transmission, though limited to the same age, has not been limited to the same sex. Consequently, the sexes when mature resemble each other and differ from the young.

CLASS IV. *When the adult [illegible]*

[illegible] adults of both sexes [illegible] brilliant[illegible] or obscurely coloured, resemble [illegible] each other [illegible] case [illegible] I think more common than [illegible] the last class. We have in England instances in the kingfisher, some woodpeckers, the jay, magpie, crow, and many small dull-coloured birds, such as the hedge-warbler or kitty-wren. But the similarity in plumage between the young and the old is never completely complete, and graduates away into dissimilarity. Thus the young of some members of the kingfisher family are not only less vividly coloured than the adults, but many of the feathers on the lower surface are edged with

paradise) ... fishes conti ue ncreasi g size, as lo g as th y are in good health d ha pl ty of food d somehat similar law may pre ail w th th plumes of birds.

Class V When the adults f both sex h distinct winter nd summer pl m g whether or not the ale d ffer f om the female the yo g embl th adults of both se thei winter d or m h mor ly their sum er d ss or they esemble the female alone Or the you g m y have ... the oter or g n, they may d ffer gr atly from th adults both their seasonal pl m g —The cases in this class are si gularly comple thus urprising, as they depend nherita ce lim ted in greater or less d gree three diff re t ways, nam ly by sex ge d th seaso of th y ar I some cases th indi duals of th sam species pass thro gh t least fi d t ct states of plum g W th th species, hich th mal diff rs from th f male during the summ seaso lo hi h is rarer dur g both seasons, th y g g rally resembl th females,—as th th so-called g ldfinch of North America, and ppare tly with th pl ndid Malurı of Australia.[a] W th these pecies, th se as of hich are alik dur g both th ummer and w n-

Jerdo B rds of Ind a, l. m., p. 507 the peacock. D Marshall th ks that th lder d more b llia t males of birds of parad se ha

Is see Aud bo Orn tholog cal Biogr phy vol. i., p. 172. For the Malurı, Gould H ndbook of th Birds f Australia, vol. i., p. 318.

case ...

arly t t of pl mag are coloured in adults dur g th ummer d th y ung of th hite-crowned parrow of North Amer ca (Fri gill leucophry), as soo as flo ged, ha l ga t whit tripe th ir h ads, h ch are lost by the y g nd th ld dur g th ter.[a] W th respect t ll th rd m ly th t of th y g ha g

ter
wi t
curs
y
ad
som ...
dia,—th y g alo be g hit

I ll mak ly f w rema k th ese complicated cases. Wh th y g resc ble th f m les th ir umm dress, r th ad lts f both se es th ir wi t dress, th ca diff from those gi nd Classes I nd III ly th charact rs riginally acq ired by th males dur g th breed ing seaso t ha g bee lim ted th transm ssi to th corre-po d g se son. Wh th ad lt ha dist ummer d t plumag nd th y g diff from both, th case is m re d ff cult t d tand. W may dmit as probabl that th y ung ... ret ed t tat f pl m ge ca account by se ual sel tio for th ummer p- f t m f th d lt b t h w are w t c-

b t th re seem good reaso f this admissio It m y be suggested th t th id ly diff re t co d li ns of lif during th ter and umm ha ted in direct ma er th plum ge thus m y ha had som ffect, b t I ha t much co fid ce so gre t diff re ce as som times see betwee th tw plumages, ha ing bee thus caused A m re probabl planatio is, th t t style of plum ge partially modif ed thro gh the transf rence of som charact rs from th ummer

tra missio ccording t ge, season, d se b t t w uld not be rth hil to mpt t f ll w t thes comple relati ns.

I am d bted t M Blyth f f rmati as t th B phus see also Jerd n, B ds f Ind l. p 749 O th Anast mus, see Blyth, Ibis 1867

th y ung of certa h rons d grets being hite. History f British B ds, l. i., 1839 p. 159.

may have varied when adult and transmitted his plumage to both adult sexes, and owing to the failure of the law of inheritance at corresponding ages, at some subsequent period to his young.

It is impossible to decide which of these three modes has generally prevailed throughout the present class of cases. That the males varied while young and transmitted their variations to their offspring of both sexes, is the most probable. I may here add that I have ... ared ... tl ... ed ... h ... T ... d ... which occur ... are transmitted to both sexes) apparently hold good in the first, second and fourth ... of ca... but they fail ...

... t ... ing the striking general ... by Dr. W. Marshall with respect to the protuberances on the head of bird ... Whether ... the two rules g... we may conclude ... that the ...

... moulting of birds ... within the same family sometimes differs much without any assignable reason. Some birds moult so early that nearly all the body feathers are cast off before the first wing feathers are fully grown ... we cannot believe that this was the primordial state of things. When the period of moulting has been accelerated ... plumage are f... to be earlier th... by the practice ... by some bird fanciers ... pulling out a few feathers from the breast of nestling bullfinches, and from the head or neck of young gold pheasants, in order to ascertain their sex; for in the males, these feathers are ... replaced by coloured ones.[38] The actual duration of life is known in but few birds, so that we can hardly judge by this ... With reference to the period at which the power of reproduction is gained, it is a remarkable fact that various birds occasionally breed whilst retaining their immature plumage.

The fact of birds breeding in their immature plumage seems opposed to the belief that sexual selection has played so important a part as I believe it has, in giving ornamental colours, plumes, &c. to the males, and by means of equal transmission, to the females of many species. The objection would be a valid one, if the younger and less ornamental males were as successful in winning females and propagating their kind, as the older and more beautiful males. But we have no reason to suppose that this is the case. Audubon speaks of the breeding of the immature males of *Ibis tantalus* ... as does Mr. S... in regard to the immature males of *Oriolus*. If the young ... of species in their immature ... adult plumage ... would pre-... retained their immature dress for the longest period ... of the species would ultimately be modified. If ... other

[38] Mr. Blyth, in *Ch...* ... p. 203). The *Ibis tantalus* ... takes four years to attain full maturity ... (... p. 133). The *C...* ... takes the same time ... but breed before acquiring full plumage (... p. 211). The adult ... resemble ... the young ...

... (... p. 614). The ... (*Birds of ... ...*, p. 210) ... breed ... Mr. Blyth ... (... July, 1863, p. 69) likewise breed before they attain their full plumage. See the list ...

... the young males of ... several ... have been known to breed whilst ... (Fritz Müller ... *Facts and Arguments for Darwin*, Eng. trans. 1869, p. 79) that the males of several ... become sexually mature before ... because they acquired their fully developed claspers. All such facts are highly interesting, as bearing on the means by which species may undergo great modifications of character.

For instance, the males of *Tanagra aestiva* and *Fringilla cyanea* require three years, the male of *Fringilla ciris* four years, to complete their beautiful plumage (see Audubon, *Ornith. Biography*, ... pp. 233, 280, 378). The Harlequin duck takes three years (*ibid.* vol. ... p. 614). The male of the gold pheasant, as I hear from Mr. J. ... W... ...

... several ... and the *Ardea ludoviciana*, two years, before they acquire their perfect plumage. See Audubon, *ibid.* vol. ... p. 221; vol. iii. pp. 133, 139, 211.

sp

u which occurred

t being th n selected—on th cont ary being oft liminated as dangerou —whilst similar ari tio occ rring t or n ar th period f reprod ti ha e been preser ed t f llo s that the plum g f th y g w ll ft has been l ft unmod fied n b t littl modified. We th s get som ns ght to th col uring f th prog nit s f o xi ting peci s. I ast n mbe f pec e in f t f six lasse f as s, tl e ad lts f n sex o f both are bright col ed t l ast d ring th breeding caso wl l t th yo g are anabl l ss brightly col red than th ad lts, are q t d ll col red f r no instance s kn as far as I can disco r f th u g f d ll-coloured peci displaying bright col s, o f th y ung f bright-col ured peci b g m brilliant than th pare ts. In the f urth class, h we in which th yo ng and th ld resembl ach th r th e ar many peci (th gh by n m an all) f which the y ung are b ght-col u ed and as th f m ld gro ps, w m y f th t th arl pro g nit rs re lik ise bright. W th this excep ti n, if look to th b rd f the w ld t p pear that th ir be uty has b n m ch in creased ce that period f which th im mature pl m g g e u a part al ecord

the e are many black and black-and wl te kinds—all tl e peci s be ng apparentl posed to ne ly tl e sam dang rs. It s th re f re prob ble tl t with tree-haunti g b rds, t o gl pron nced colo s l e bee q red tl rough sexual select n but th t a green t t has been acq red oftener tl n a y otl r from tl e add ti n l advantag of pro tect

In regard to b rds which l o the grou d e rs one adm ts th t they are colo red so as t m tate tl rrou d g s face H w diffi c lt it is t see a p rtr dge s pe woodcock, certain plo r larks, a d night jars wl n cro ched n grou d A m ls nhab t g des e ts ff r th m t t king cases, f r th bare *surface aff rd no co cealm nt* and n arly all th mall *quadrupeds, reptil s,* and birds de pe d f saf ty o tl r colo rs. M Tristram has remarked i regard t the inh b tants f th Sal ara, that all re protected by th r isab ll n r sand-col u [59] Call ng t my ecollect n th d sert bird of So th Am ca, as w ll as most f the gro nd-b rd of Gre t

D the Colo f the Pl m p lat on to P otection.—It will ha been seen th t I can t f ll w Mr Wallace th b l f that dull lours, wh n co fined t th f m l h e bee most cases pecially gained f th sak f protecti Th re can, h w b d bt, as f tmerly remarked that both sex of man b rd h had th col urs mod fied so as t scape th n t f th m r in som instance so as to pproach th p y un bserved j t as wls h had th ir pl m ag rend red soft th t th flight m t b h ard M Wallace marks[58] th t t nly th trop s, am g f re ts wh ch n lose the f li g th t w find wh l g p f b rds, wh se clu f col is gre n. It will be admitted by ry wh has t ed h w d fficult t is t d tingu h pa ts l af-co ed tree N th l ss w m t m mbe th t many parrots are rnam nted with crimson, bl and ang ti ts, which can hardly be prot cti Woodpeck rs ar emin tly arboreal, b t besid green peci s,

th se b rds t d ff from that of tl e co g n rs. B tl se f thirteen t of th tw ty si spec are col red n the same mann r b t th se bel g to g n ra in wh l tl rule comm nly p ls, so th t th y t ll noth ing bo t th protect col rs b g the same n b th se f dese t birds. Of tl th r th teen pecies tl ee b l g t g n n whicl tl se u ally diffe from ach th r y t h re tl y h th se alik In the remain ing t pec s th male *diff rs from tl e fe* mal b t the d ff re ce confined ch fl to th und urface f th pl m g wh h co ce led wh n th b rd cro ch th g o nd the h d and back b ing f th sam m d col ed h m th tw se s. So th t n th se t n peci th ppe su face f b th se s ha been cted and rend red like thro gh n t al selecti n, fo the sak f protect n whilst th l w r s rface f the mal l ne

[58] *W estm nster Review* July 1867 p. 5.

[59] *Ibis* 1859 l. p. 429 t q D Rohlfs, h w ever remarks t m l tt th t ccordi g t his xperi ce of th Sahara, this tatem t is too tro g

CLASS VI *The young in their first plumage differ from each other according to sex the young males resembling more or less closely the adult males and the young females more or less closely the adult females.*—The cases in the present class, though occurring in various groups, are not numerous yet it seems the most natural thing that the young should at first somewhat resemble the adult ... and The ... ch ... rown and I ... rmed by Mr Blyth that the young of both sexes can be distinguished by this character even as nestlings. In the family of the thrushes an unusual number of similar cases have been noticed thus, the male blackbird (*Turdus merula*) can be distinguished in the nest from the female. The two sexes of the mocking bird (*Turdus polyglottus* Linn.) differ very little from each other yet the males can ... ly be distinguished at a very early age from the females by showing more pure white.[16] The males of a forest thrush and of a rock thrush (*Orocetes erythrogastra* and *Petrocincla cyanea*) h ... e e g ... w in blue whilst the ... f the females are edged with brown.[17] In the young blackbird the wing feathers assume their mature character and become black after the others on the other hand in the two species just named the wing feathers become blue before the others. The most probable view with reference to the cases in the present class is that the males, differently from what occurs in Class I have transmitted their colours to their male offspring at an earlier age than that at which they were first acquired for ... if they had varied whilst quite young their characters would probably have been transmitted to both sexes.[18]

In *Aithurus polytmus* a humming bird the male is splendidly coloured black and green and two of the tail feathers are immensely lengthened the female has an ordinary tail and inconspicuous colours now the young males, instead of resembling the adult female in accordance with the common rule begin from the first to assume the colours proper to their sex and their tail-feathers soon become lengthened. I owe this information to Mr Gould who has given me the following more striking and as yet unpublished case. Two humm ... ging to the ... oloured, in ... , and have ... tinct. But it ... y been ascertained that the one which is of a rich chestnut brown colour with a golden-red head, is the male whilst the other which is elegantly variegated with green and white with a metallic green head is the female. Now the young from the first somewhat resemble the adults of the corresponding sex the resemblance gradually becoming more and more complete.

In considering this last case if we before take the plumage of the young as our guide it would appear that both sexes have been rendered beautiful independently and not that one sex has partially transferred its beauty to the other. The male apparently has acquired his bright colours through sexual selection in the same manner as, for instance the peacock or pheasant in our first class of cases and the female ... the same manner as the female Rhynchaea or Turnix ... our second class of cases. But there is much difficulty in understanding how this could have been effected at the same time with the two sexes of the same species. Mr Salvin states, as we have seen in the eighth chapter that with certain humming birds the males greatly exceed the females in number whilst with other species inhabiting the same country the females greatly exceed the males. If then ... might ... m ... t during some former ... long the ... d period ... of the Ju n F ... spec ... had greatly exceeded the females in number but that during another long-continued period the females had far exceeded the males, we could understand how the males at one time and the females at another might have been rendered beautiful by the s ... ct ... f ... in true explanation I will not pretend to say but the case is too remarkable to be passed over without notice.

We have now seen in all six classes that an intimate relation exists b tw ... e ... principle that one sex—this being in the great majority of cases the male—first acquired through variation and sexual selection bright colours or other ornaments, and transmitted them in various ways, in accordance with the recognised laws of inheritance. Why variation has occurred at different periods of life even sometimes with species of the same group we do not know but with respect to the form of transmission one important determining cause seems to be the age at which the variations first appear.

[15] Audubon *Ornith. Biography* vol. ... p. 113.

[16] Mr C. A. Wright in *Ibis* vol. ... 1864 p. 65. Jerdon *Birds of India* ... p. 515. See also on the blackbird Blyth in *Charlesworth's Magazine of Natural History* ... 1837 p. 113.

[17] The following additional cases may be mentioned the young males of ... can be distinguished from the ... s (Audubon ... d so ... is ... *D ... phila* ... p ... Mr Blyth has informed me that the sexes of the stonechat, *Saxicola rubicola* are distinguishable at a very early age. Mr Salvin gives (*Proc. Zoolog. Soc.* 1870 p. 206) the case of a humming bird, like the following one of Eustephanus.

ed with plumes so long as to impede their flight.

In the same manner as the males alone of various species are black, the females being dull-coloured, so in a few cases the males alone are either wholly or partially white, as with the several bell-birds of South America (Chasmorhynchus), the Antarctic goose (*Bernicla antarctica*), the silver-pheasant, &c., whilst the females are brown or obscurely mottled. Therefore, on the same principle as before, it is probable that both sexes of many birds, such as white cockatoos, several egrets with their beautiful plumes, certain ibises, gulls, terns, &c., have acquired their more or less completely white plumage through sexual selection. In some of these cases the plumage becomes white only at maturity. This is the case with certain gannets, tropic-birds, &c., and with the snow goose (*Anser hyperboreus*). As the latter breeds on the "barren grounds," which are not covered with snow, and as it migrates southward during the winter, there is no reason to suppose that its snow-white adult plumage serves as protection. In the *Anastomus oscitans* we have still better evidence that the white plumage is a nuptial character, for it is developed only during the summer; the young in their immature state, and the adults in their winter dress, being grey and black. With many kinds of gulls (Larus), the head and neck become pure white during the summer, being grey or mottled during the winter and in the young state. On the other hand, with the smaller gulls, or sea-mews (Gavia), and with some terns (Sterna), exactly the reverse occurs; for the heads of the young birds during the first year, and of the adults during the winter, are either pure white or much paler coloured than during the breeding-season. These latter cases offer another instance of the capricious manner in which sexual selection appears often to have acted.

That aquatic birds have acquired a white plumage so much oftener than terrestrial birds, probably depends on their large size and strong powers of flight, so that they can easily defend themselves or escape from birds of prey, to which moreover they are not much exposed. Consequently sexual selection has not here been interfered with or guided for the sake of protection. No doubt with birds which roam over the open ocean, the males and females could find each other much more easily when made conspicuous either by being perfectly white or intensely black; so that these colours may possibly serve the same end as the call-notes of many land-birds.[44] A white or black bird when it discovers and flies to a carcase floating on the sea or cast up on the beach, will be seen from a great distance, and will guide other birds of the same and other species, to the prey; but as this would be a disadvantage to the first finders, the individuals which were the whitest or blackest would not thus procure more food than the less strongly coloured individuals. Hence conspicuous colours cannot have been gradually acquired for this purpose through natural selection.

As sexual selection depends on so fluctuating an element as taste, we can understand how it is that, within the same group of birds having nearly the same habits, there should exist white or nearly white, as well as black, or nearly black species,—for instance, both white and black cockatoos, storks, ibises, swans, terns, and petrels. Piebald birds likewise sometimes occur in the same groups together with black and white species; for instance, the black-necked swan, certain terns, and the common magpie. That a strong contrast in colour is agreeable to birds, we may conclude by looking through any large collection, for the sexes often differ from each other in the male having the pale parts of a pure white, and the variously coloured dark parts of still darker tints than the female.

It would even appear that mere novelty, or slight changes for the sake of change, have sometimes acted on female birds as a charm, like changes of fashion with us. Thus the males of some parrots can hardly be said to be more beautiful than the females, at least according to our taste, but they differ in such points, as in having a rose-coloured collar instead of "a bright emeraldine narrow green collar;" or in the male having a black collar instead of "a yellow demi-collar in front," with a pale roseate instead of a plum-blue head.[45] As so many

[43] On Larus, Gavia, and Sterna, see Macgillivray, *History of British Birds*, vol. v. pp. 515, 584, 626. On the *Anser hyperboreus*, Audubon, *Ornithological Biography*, vol. iv. p. 562. On the Anastomus, Mr. Blyth, in *Ibis*, 1867, p. 173.

[44] It may be noticed that with vultures, which roam far and wide high in the air, like marine birds over the ocean, three or four species are almost wholly or largely white, and that many others are black. So that here again conspicuous colours may possibly aid the sexes in finding each other during the breeding-season.

[45] See Jerdon on the genus Palæornis, *Birds of India*, vol. i., pp. 258-260.

have been diversified through sexual selection for the sake of ornament Here as both sexes are equally well prot

[illegible]

[illegible] that we must look to the law of sexually limited transmission

In all parts of the world both sexes of many soft billed birds especially those which frequent reeds or sedges are obscurely coloured No doubt if their colours had been brilliant they would have been much more conspicuous to their enemies but whether their dull tints have been specially gained for the sake of protection seems as far as I can judge rather doubtful It is still more doubtful whether such dull tints can have been gained for the sake of ornament We must however bear in mind that male birds though dull coloured often differ much from their females (as with the common sparrow) and this leads to the belief that such colours have been gained through sexual selection from being attractive Many of the soft billed birds are songsters and a discussion in a former chapter should not be forgotten in which it was shewn that the best songsters are rarely ornamented with bright tints It would appear that female birds as a general rule have selected their mates either for their sweet voices or gay colours but not for both charms combined Some species which are manifestly [illegible]

[illegible] our standard of taste with extreme elegance In such cases we may conclude that both natural and sexual selection have acted conjointly for protection and ornament Whether any bird exists which does not possess some special attraction by which to charm the opposite sex may be doubted When both sexes are so obscurely coloured that it would be rash to assume the agency of sexual selection and when no direct evidence can be advanced shewing that such colours serve as a protection it is best to own complete ignorance of the cause or which comes to nearly the same thing to attribute the result to the direct action of the conditions of life

[illegible] in one of the birds of paradise (*Lophorina atra*) the m [illegible]

[illegible] been a sexually selected character Therefore it is in some degree probable that the complete or partial blackness of both sexes in such birds as crows certain cockatoos, storks and swans and many marine birds, is likewise the result of sexual selection accompanied by equal transmission to both sexes for blackness can hardly serve in any case as a protection With several birds, in which the male alone is black and in others in which both sexes are black the beak or skin about the head is brightly coloured and the contrast thus afforded adds much to their beauty we see this in the bright yellow beak of the male blackbird in the crimson skin over the eyes of the blackcock and capercailzie in the brightly and variously coloured [illegible]

[illegible] leads me to remark that it is not incredible that toucans may owe the enormous size of their beaks to sexual selection for the sake of displaying the diversified and vivid stripes of colour with which these organs are ornamented [51] The naked skin also at the base of the beak and round the eyes is likewise often brilliantly coloured and Mr Gould in speaking of one species [52] says that the colours of the beak are doubtless in the finest and most brilliant state during the time of pairing There is no greater improbability that toucans should be encumbered with immense beaks though rendered as light as possible by their cancellated structure for the display of fine colours (an object falsely appearing to us unimportant) than that the male Argus pheasant and some other birds should be encumber

[51] [illegible] explanation of the enormous size of the beak, and likewise of the bright colours [illegible] Mr Bates (*The Naturalist on the Amazons* [illegible] 1863 p 341) states that they use their beaks for reaching fruit at the [illegible] branches [illegible] But Mr Belt [illegible] the beak [illegible] perfectly [illegible] that it serves [illegible]

[illegible] Mr Belt believes (*The Naturalist in Nicaragua* p 197) that the principal use of the beak [illegible]

[52] *Rhamphastos carinatus* Gould *Monograph of Ramphastidae*

same g ral style f ornamentati n o ther attractions, and yet appreciating l ght changes in colours, form o sound

S mmary f the F Chapt s Birds.—Most m le birds are highly pugnaci s during th breed se son and some possess w pons

o r to charm th f mal s b l ve-d ces or antics, perfo med n th grou d n tl

by far tl comm t m ns l som cases m re lt ppears t l ted as a charm Th ru m t f tl m l m t be highly mpo tant t th m f tl l been acq ired in t f ase t tl cost f in creased dang from and t som loss f po in fi hting w th th m ls. Th mal s f rs many pec do t as me the rnam tal dress t l tl n e t m turnt th ssum t l d g th breed ing season. th t t tl becom n re nd Certai rnamental ppend ge becom nlarged t gid d brightly col red d n g th act f co rtsh p Th m l d play tl ir harms w th labo t re and t th be t ffect and thu is d th pre ce f th f males Th co tship som t pro lo ged affai at d man m l d f males

decorations, all th pomp an l d pl y are useless and this red bl B rds ha fin po rs f disc mn tio and some f w tances t an b h wn that tl h tast f th be tif l Th f males, m reo are know occas nall to xh b t ma ked pre f re ce antipathy f ce tain ind d al males

If t be adm tted that the f males prefer o are unconsc ously excited by the more beauti ful mal s, then the males would slowly l ut rely be rend red m re and more attracti e thro gh se u l selecti n That it is ll sex h cl l as been chi fly modified we may infer from th fa t that n almost every g n s wl ere tl e se es d ff r the males d ff r n l n re fro n on an th r than do th f mal s thus is ll sl ewn m certain closely-all ed wh l tl f males

ffice f tl wo k of sexual select on

and t the n t re f the t ps thro gl wl t th ha e passed Th y xplain also tl mo t tere tu g mann r h w certain charac t rs h rigi ated ch as the nd ted ocell n the tail f th rs of th peacock, l th ball-and sock t ocell on the wing f th rs f tl Argu pl asant It e nd t that tl brill t colo rs, t p-knots, fin pl m s, &c f many n al b rd un t ha been equ red as a protect ndeed th y somet mes l d to lan That th y are not d e to the d rect and d finite act n f the co d t ns f life we may feel assured bec se tl femal s ha bee posed t tl sam co dit ns and y t ft n diff from th males t n trem de gree Alth gh t is probabl that changed co d t ons t ng duri g a l ngth ed per od ha some a produced d finite ffect both se s, o som tim n e sex al e, th m re mpo tant re lt will ha been an reased t d y t ary t present m re tro gly ma k d d ad l d ff re ce and ch difference will ha e aff rded an xcel l t ground w k f the action f sexual select

Th l s f nh rıtance, irrespecti ely of select n ppe t ha dete mined wh tl th char t rs q red by th mal f the sak f rn m t f prod cing an u so d an l f fight g t th ha e been t m t t d t th mal al or to both sex s, ther pe ma tly period ally d r g ce t n aso f tl year Why arı cl r t should ha been tr nsmitted som tim s in

ters or elon
the short-
formerly described in the male of a humming bird and the shortened crest of the male goosander seem like one of the many changes of fashion which we admire in our own dresses

Some members of the heron family offer a still more curious case of novelty in colouring having as it appears been appreciated for the sake of novelty The
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mage of the allied *Buphus coromandus* are white this colour changing into a rich golden buff during the breeding season It is incredible that the young of these two species as well as of some other members of the same family[14] should for any special purpose have been rendered pure white and thus made conspicuous to their enemies or that the adults of one of these two species should have been specially rendered white during the winter in a country which is never covered with snow On the other hand we have good reason to believe that whiteness has been gained by many birds as a sexual ornament We may therefore conclude that some early progenitor of the *Ardea asha* and the Buphus acquired a white plumage for nuptial purposes and transmitted this colour to their young so that the young and the old became white like certain existing egrets and that the whiteness was afterwards retained by the young whilst it was exchanged by the adults for more strongly pronounced tints But if we could look still further back to the still earlier progenitors of these two species we should probably see the adults dark coloured I infer that this would be the case from the analogy of many other birds which are dark whilst young and when adult are white and more especially from the case of the *Ardea gularis* the colours of which are the reverse of those of *A asha* for the young are dark-coloured and the adults white the young having retained a former state of plumage It appears therefore that during a long line of descent the adult progenitors of the *Ardea asha* the Buphus and of some allies have undergone the following changes of colour first a dark shade secondly pure white and thirdly owing to another change of fashion (if I may so express myself) their present slaty reddish or golden buff tints These successive changes are intelligible only on the principle of novelty having been admired by birds for its own sake

Several writers have objected to the whole theory of sexual selection by assuming that with animals and savages the taste of the female for certain colours or other ornaments would not remain constant for many generations that first one colour and then another would be admired and consequently that no permanent effect could be produced We may admit that taste is fluct
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ated Abundant evidence will be given in two places in a future chapter that savages of many races have admired for many generations the same cicatrices on the skin the same hideously perforated lips, nostrils, or ears distorted heads, &c and the se deformities present some analogy to the natural ornaments of various animals. Nevertheless, with savages such fashions do not endure for ever as we may infer from the differences in this respect between allied tribes on the same continent So again the raisers of fancy animals certainly have admired for many generations and still admire the same breeds they earnestly desire slight changes, which are considered as improvements but any great or sudden change is looked at as the greatest blemish With birds in a state of nat
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ing the case We know that dovecot pigeons do not willingly associate with the variously coloured fancy breeds that albino birds do not commonly get partners in marriage and that the black ravens of the Feroe Islands chase away their piebald brethren But this dislike of a sudden change would not preclude their appreciating slight changes, any more than it does in the case of man Hence with respect to taste which depends on many elements but partly on habit and partly on a love of novelty there seems no improbability in animals admiring for a very long period the

[14] The young of *Ardea rufescens* and *A cærulea* of the United States are likewise white the adults being coloured in accordance with the specific names. Audubon (*Ornithological Biography*, vol. iii. p 416 vol iv p 58) seems rather pleased at the thought that this remarkable change of plumage will greatly disconcert the systematists."

su ace in tl males alo e has been n u ly ornamented thro gh sexual select n. I nally from tl facts g n tl ese f u ch pt rs, we may concl d th t weapons f b ttle organs for producing sound am ts f many kinds, bri ht and con p cu us colours, h g nerally bee acquired by th mal thro gh ariatio and sexual selecti n, and h e been transmitted in ari us w ccordin to th several law of inh ritance—th females and tl e y g being left comparati ly but little mod fied [37]

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ything as fact which as guished naturalist to be erroneous. But of course he is ot t all nswerable f th accuracy of th statements quoted by m from various thorities.

one way and sometimes in another is not in most cases known but the period of variability seems often to have been the determining cause When the two sexes have inherited all *characters in common* they necessarily resemble each other but as the successive variations may be differently transmitted every possible gradation may be found even within the same genus from the closest similarity to the widest dissimilarity between the sexes With many closely allied species following nearly the same habits of life the males have come to differ from each other chiefly through the action of sexual selection whilst the females have come to differ chiefly from partaking more or less of the characters thus acquired by the males The effects moreover of the definite action of the conditions of life will not have been masked in the females as in the males, by the accumulation through sexual selection of *strongly pronounced colours* and other ornaments The individuals of both sexes however affected will have been kept at each successive period nearly uniform by the free intercrossing of many individuals

With species in which the sexes differ in colour it is possible or probable that some of the successive variations often tended to be transmitted equally to both sexes but that when this occurred the females were prevented from acquiring the bright colours of the males by the destruction which they suffered during incubation There is no evidence that it is possible by natural selection to convert one form of transmission into another But there would not be the least difficulty in rendering a female dull-coloured the male being still kept bright coloured by the selection of successive variations, which were from the first limited in their transmission to the same sex Whether the females of many species have actually been thus modified must at present remain doubtful When through the law of the equal transmission of characters to both sexes the females were rendered as conspicuous in colour as the males, their instincts appear often to have been modified so that they were led to build domed or concealed nests

In one small and curious class of cases the characters and habits of the two sexes have been completely transposed for the females are larger stronger more vociferous and brighter coloured than the males They have also become so quarrelsome that they often fight together for the possession of the males, like the males of other pugnacious species for the possession of the females. If as seems probable such females habitually drive away their rivals, and by the display of their bright colours or other charms endeavour to attract the males, we can understand how it is that they have gradually been rendered, by sexual selection and sexually limited transmission more beautiful than the males—the latter being left unmodified or only slightly modified

Whenever the law of inheritance at corresponding ages prevails but not that of sexually limited transmission then if the parents vary late in life—and we know that this constantly occurs with our poultry and occasionally with other birds—the young will be left unaffected whilst the adults of both sexes will be modified If both these laws of inheritance prevail and either sex varies late in life that sex alone will be modified the other sex and the young being *unaffected* When variations in brightness or in other conspicuous characters occur early in life as no doubt often happens they will not be acted on through sexual selection until the period of reproduction arrives

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tions arising late in life have so often been preserved for the ornamentation of the males the females and the young being left almost unaffected and therefore like each other With

during the summer alone the degrees and kinds of resemblance between the young and the old are exceedingly complex and this complexity apparently depends on characters, first acquired by the males, being transmitted in various ways and degrees, as limited by age sex and season

As the young of so many species have been but little modified in colour and in other ornaments we are enabled to form some judgment with respect to the plumage of their early progenitors and we may infer that the beauty of our existing species, if we look to the whole class has been largely increased since that period of which the immature plumage gives us an indirect record Many birds, especially those which live much on the ground have undoubtedly been obscurely coloured for the sake of protection In some instances the upper exposed surface of the plumage has been thus coloured in both sexes, whilst the lower

lopes in which the females are hornless. With many animals the canine teeth in the upper or lower jaw, or in both, are much larger in the males than in the females, or are absent in the latter, with the exception sometimes of a hidden rudiment. Certain antelopes, the musk-deer, camel, horse, boar, various apes, seals, and the walrus, offer instances. In the females of the walrus the tusks are sometimes quite absent. In the male elephant of India and in the male dugong the upper incisors form offensive weapons. In the male narwhal the left canine alone is developed into the well-known, spirally-twisted, so-called horn, which is sometimes from nine to ten feet in length. It is believed that the males use these horns for fighting together; for an unbroken one can rarely be got, and occasionally one may be found

female both are always rudimentary. The male cachalot has a larger head than that of the female, and it no doubt aids him in his aquatic battles. Lastly, the adult male Ornithorhynchus is provided with a remarkable apparatus, namely a spur on the foreleg, closely resembling the poison-fang of a venomous snake; but according to Harting, the secretion from the gland is not poisonous; and on the leg of the female there is a hollow, apparently for the reception of the spur.

When the males are provided with weapons which in the females are absent, there can be hardly a doubt that these serve for fighting with other males; and that they were acquired through sexual selection, and were transmitted to the male sex alone. It is not probable, at least in most cases, that the females have been prevented from acquiring such weapons, on account of their being useless, superfluous, or in some way injurious. On the contrary, as they are often used by the males for various purposes, more especially as a defence against their enemies, it is a surprising fact that they are so poorly developed, or quite absent, in the females of so many animals. With female deer the development during each recurrent season of great branching horns, and with female elephants the development of immense tusks, would be a great waste of vital power, supposing that they were of no use to the females. Consequently they would have tended to be eliminated in the female through natural selection; that is, if the successive variations were limited in their transmission to the female sex, for otherwise the weapons of the males would have been injuriously affected, and thus would have been a greater evil. On the whole, and from the consideration of the following facts, it seems probable that when the various weapons differ in the two sexes, this has generally depended on the kind of transmission which has prevailed.

As the reindeer is the one species in the whole family of deer in which the female is furnished with horns, though they are somewhat smaller, thinner and less branched than in the male, it might naturally be thought that, at least in this case, they must be of some special service to her. The female retains her horns from the time when they are fully developed, namely, in September, throughout the winter until April or May, when she brings forth her young. Mr. Crotch made particular enquiries for me in Norway, and it appears that the females at this season conceal themselves for about a fortnight in order to bring forth their young, and then reappear generally hornless. In Nova Scotia, however, as I hear from Mr. H. Reeks, the female sometimes retains her horns longer. The male on the other hand casts his horns much earlier, towards the end of November. As both sexes have the same requirements and follow the same habits of life, and as the male is destitute of horns during the winter, it is improbable that they can be of any special service to the female during this season, which includes the larger part of the time during which she is horned. Nor is it probable that she can have inherited horns from some ancient progenitor of the family of deer, for, from the fact of the females of so many species in all quarters of

Mr. Lamont, 'Seasons with the Sea-Horses,' 1861, p. 143, says that a good tusk of the male walrus weighs 4 pounds, and is longer than that of the female, which weighs about 3 pounds. The males are described as fighting ferociously. On the occasional absence of the tusks in the female, see Mr. R. Brown, 'Proc. Zoolog. Soc.' 1868, p. 429.

Owen, 'Anatomy of Vertebrates,' vol. iii. p. 283.

Mr. R. Brown, 'Proc. Zool. Soc.' 1869, p. 553. See Prof. Turner, in 'Journal of Anat. and Phys.' 1872, p. 76, on the homological nature of these tusks. Also Mr. J. W. Clarke on two tusks being developed in the males, in 'Proceedings of the Zoological

ii. p. 292.

CHAPTER XVII

SECONDARY SEXUAL CHARACTERS OF MAMMALS

With mammals the male appears to win the female much more through the law of battle than through the display of his charms. The most timid animals, not provided with any special weapons for fighting, engage in desperate conflicts during the season of love. Two male hares have been seen to fight together until one was killed; male moles often fight, and sometimes with fatal results; male squirrels engage in frequent contests, and often wound each other severely; as do male beavers, so that hardly a skin is without scars. I observed the same fact with the hides of the guanacoes in Patagonia; and on one occasion several were so absorbed in fighting that they fearlessly rushed close by me. Livingstone speaks of the males of the many animals in Southern Africa as almost invariably showing the scars received in former contests.

The law of battle prevails with aquatic as with terrestrial mammals. It is notorious how desperately male seals fight, both with their teeth and claws, during the breeding season; and their hides are likewise often covered with scars. Male sperm whales are very jealous at this season; and in their battles they often lock their jaws together, and turn on their sides and twist about; so that their lower jaws often become distorted.

All male animals which are furnished with special weapons for fighting, are well known to engage in fierce battles. The courage and the desperate conflicts of stags have often been described; their skeletons have been found in various parts of the world, with the horns inextricably locked together, showing how miserably the victor and vanquished had perished. No animal in the world is so dangerous as an elephant in must. Lord Tankerville has given me a graphic description of the battles between the wild bulls in Chillingham Park, the descendants, degenerated in size but not in courage, of the gigantic *Bos primigenius*. In 1861 several contended for mastery; and it was observed that two of the younger bulls attacked in concert the old leader of the herd, overthrew and disabled him, so that he was believed by the keepers to be lying mortally wounded in a neighbouring wood. But a few days afterwards one of the young bulls approached the wood alone; and then the monarch of the chase, who had been lashing himself up for vengeance, came out and, in a short time, killed his antagonist. He then quietly joined the herd, and long held undisputed sway. Admiral Sir B. J. Sulivan informs me that, when he lived in the Falkland Islands, he imported a young English stallion, which frequented the hills near Port William with eight mares. On these hills there were two wild stallions, each with a small troop of mares; and it is certain that these stallions would never have approached each other without fighting. Both had tried singly to fight the English horse and drive away his mares, but had failed. One day they came in *together* and attacked him. This was seen by the captain who had charge of the horses, and who, on riding to the spot, found one of the two stallions engaged with the English horse, whilst the other was driving away the mares, and had already separated four from the rest. The captain settled the matter by driving the whole party into a corral, for the wild stallions would not leave the mares.

Male animals which are already provided with efficient cutting or tearing teeth for the ordinary purposes of life, as in the case of the Carnivora, Insectivora, and Rodents, are seldom furnished with weapons especially adapted for fighting with their rivals. The case is very different with the males of many other animals. We see this in the horns of stags and of certain kinds of ant-

See Waterton [illegible] on two hares fighting, *Zoologist*, vol. i. 1843, p. 211. On moles, Bell, *Hist. of British Quadrupeds*, 1st ed., p. 100. On squirrels, Audubon and Bachman, *Viviparous Quadrupeds of N. America*, 1846, p. 269. On beavers, Mr. A. H. Green, in *Journal of Linnean Society, Zoology*, [illegible]

[illegible] p. 414 also [illegible] On the sperm whale, see Mr. J. H. Thompson, in *Proc. Zool. Soc.* 1867, p. 246. See Scrope (*Art of Deer-stalking*, p. 17) on the locking of the horns with the *Cervus elaphus*. Richardson, in *Fauna Bor. Americana*, 1829, p. 252, says that the [illegible] have been found thus locked together. [illegible] the Cape of Good Hope [illegible] in the same condition.

in the bull than in the cow; and in the cow-banteng (*Bos sondaicus*) the horns are remarkably small, and inclined much backwards. In the domestic races of cattle, both of the humped and humpless types, the horns are short and thick in the bull, longer and more slender in the cow and ox; and in the Indian buffalo, they are shorter and thicker in the bull, longer and more slender in the cow. In the wild gaour (*B. gaurus*) the horns are mostly both longer and thicker in the bull than in the cow.[15] Dr. Forsyth Major also informs me that a fossil skull, believed to be that of the female *Bos etruscus*, has been found in Val d'Arno, which is wholly without horns. In the *Rhinoceros simus*, as I may add, the horns of the female are generally longer but less powerful than in the male; and in some other species of rhinoceros they are said to be shorter in the female.[16] From these various facts we may infer as probable that horns of all kinds, even when they are equally developed in the two sexes, were primarily acquired by the male in order to conquer other males, and have been transferred more or less completely to the fe-

male reindeer, however, must be excepted, as after castration he does renew them. This fact, as well as the possession of horns by both sexes, seems at first to prove that the horns in this species do not constitute a sexual character; but as they are developed at a very early age, before the sexes differ in constitution, it is not surprising that they should be unaffected by castration, even if they were aboriginally acquired by the male. With sheep both sexes properly bear horns; and I am informed that with Welch sheep the horns of the males are considerably reduced by castration; but the degree depends much on the age at which the operation is performed, as is likewise the case with other animals. Merino rams have large horns, whilst the ewes generally speaking are without horns; and in this breed castration seems to produce a somewhat greater effect, so that if performed at an early age the horns remain almost undeveloped.[18] On the Guinea coast there is a breed in which the females never bear horns, and, as Mr. Winwood Reade informs me, the rams after castration are quite destitute of them. With cattle the horns of the males are much altered by castration; for instead of being short and thick, they become longer than those of the cow, but otherwise resemble them. The *Antilope bezoartica* offers a somewhat analogous case: the males have long straight spiral horns, nearly parallel to each other, and directed backwards; the females occasionally bear horns, but these when present are of a very different shape, for they are not spiral, and spreading widely, bend round with the points forwards. Now it is a remarkable fact that, in the castrated male, as Mr. Blyth informs me, the horns are of the same peculiar shape as in the female, but longer and thicker. If we may judge from analogy, the female probably shews us, in these two cases of cattle and the antelope, the former condition of the horns in some early progenitor of each species. But why castration should lead to the reappearance of an early condition of the horns cannot be explained with any certainty. Nevertheless, it seems probable that in nearly the same manner as the constitutional disturbance in the offspring, caused by a cross between two distinct species or races, often leads to the reappearance of long-lost characters;[19] so here the disturbance in the constitution of the individual, resulting from castration, produces the same effect.

The tusks of the elephant, in the different species or races, differ according to sex, nearly as do the horns of ruminants. In India and Malacca the males alone are provided with well-developed tusks. The elephant of Ceylon is considered by most naturalists as a distinct race, but by some as a distinct species, and here not one in a hundred is found with tusks, the few that possess them being exclusively males.[20] The African elephant is undoubtedly distinct, and the female has large

[15] 'Land and Water,' 1867, p. 346.

[16] Sir Andrew Smith, 'Zoology of S. Africa,' pl. xix. Owen, 'Anatomy of Vertebrates,' vol. iii. p. 624.

[17] This is the conclusion of Seidlitz, 'Die Darwinsche Theorie,' 1871, p. 47.

[18] I am much obliged to Prof. Victor Carus, for having made enquiries for me in Saxony on this subject. H. von Nathusius ('Viehzucht,' 1872, p. 64) says that the horns of sheep castrated at an early period, either altogether disappear or remain as mere rudiments; but I do not know whether he refers to merinos or to ordinary breeds.

[19] I have given various experiments and other evidence proving that this is the case, in my 'Variation of Animals and Plants under Domestication,' vol. ii. 1868, pp. 39–47.

[20] Sir J. Emerson Tennent, 'Ceylon,' 1859, vol. ii. p. 274. For Malacca, 'Journal of Indian Archipelago,' vol. iv. p. 357.

the globe not having horns, we may conclude that this was the primordial character of the group.[8]

The horns of the reindeer are developed at a most unusually early age; but what the cause of this may be is not known. The effect has apparently been the transference of the horns to both sexes. We should bear in mind that horns are always transmitted through the female, and that she has a latent capacity for their development, as we see in old or diseased females.[9] Moreover the females of some other species of deer exhibit, either normally or occasionally, rudiments of horns; thus the female of *Cervulus moschatus* has "bristly tufts, ending in a knob, instead of a horn;" and "in most specimens of the female wapiti (*Cervus canadensis*) there is a sharp bony protuberance in the place of the horn."[10] From these several considerations we may conclude that the possession of fairly well-developed horns by the female reindeer, is due to the males having first acquired them as weapons for fighting with other males; and secondarily to their development from some unknown cause at an unusually early age in the males, and their consequent transference to both sexes.

Turning to the sheath-horned ruminants: with antelopes a graduated series can be formed, beginning with species, the females of which are completely destitute of horns—passing on to those which have horns so small as to be almost rudimentary (as with the *Antilocapra americana*, in which species they are present in only one out of four or five females[11])—to those which have fairly developed horns, but manifestly smaller and thinner than in the male and sometimes of a different shape,[12]—and ending with those in which both sexes have horns of equal size. As with the reindeer, so with antelopes, there exists, as previously shewn, a relation between the period of the development of the horns and their transmission to one or both sexes; it is therefore probable that their presence or absence in the females of some species, and their more or less perfect condition in the females of other species, depends, not on their being of any special use, but simply on inheritance. It accords with this view that even in the same restricted genus both sexes of some species, and the males alone of others, are thus provided. It is also a remarkable fact that, although the females of *Antilope bezoartica* are normally destitute of horns, Mr. Blyth has seen no less than three females thus furnished; and there was no reason to suppose that they were old or diseased.

ho[illegible] a[illegible] sometimes quite absent in the latter.[13] In several domestic breeds of these two animals, the males alone are furnished with horns; and in some breeds, for instance in the sheep of North Wales, though both sexes are properly horned, the ewes are very liable to be hornless. I have been informed by a trustworthy witness, who purposely inspected a flock of these same sheep during the lambing season, that the horns at birth are generally more fully developed in the male than in the female. Mr. J. Peel crossed his Lonk sheep, both sexes of which always bear horns, with hornless Leicesters and hornless Shropshire Downs; and the result was that the male offspring had their horns considerably reduced, whilst the females were wholly destitute of them. These several facts indicate that, with sheep, the horns are a much less firmly fixed character in the females than in the males; and this leads us to look at the horns as properly of masculine origin.

With the adult musk-ox (*Ovibos moschatus*) the horns of the male are larger than those of the female, and in the latter the bases do not touch.[14] In regard to ordinary cattle Mr. Blyth remarks: "In most of the wild bovine animals the horns are both longer and thicker

[8] On the structure and shedding of the horns of the reindeer, Hoffberg, 'Amoenitates Acad.' vol. iv. 1788, p. 149. See Richardson, 'Fauna Bor. Americana,' p. 241, in regard to the American variety or species: also Major W. Ross King, 'The Sportsman in Canada,' 1866, p. 80.

[9] Isidore Geoffroy St. Hilaire, 'Essais de Zoolog. Générale,' 1841, p. 513. Other masculine characters, besides the horns, are sometimes similarly transferred to the female; thus Mr. B[illegible] f[illegible]

[10] On the Cervulus, Dr. Gray, 'Catalogue of Mammalia in the British Museum,' part iii. p. 220. On the Cervus canadensis or wapiti, see Hon. J. D. Caton, 'Ottawa Acad. of Nat. Science,' May, 1868, p. 9.

[11] I am indebted to Dr. Canfield for this information; see also his paper in the 'Proceedings of the Zoological Society,' 1866, p. 105.

[12] For instance the horns of the female *Ant. euchore* resemble those of a distinct species, viz. the *Ant. dorcas* var. *corine*, see Desmarest, 'Mammalogie,' p. 455.

[13] Gray, 'Catalogue of Mammalia, the British Museum,' part iii. 1852, p. 160.

[14] Richardson, 'Fauna Bor. Americana,' p. 278.

Fi 63 O y l ory m l (from th *Knowsley Men gerı*)

af rms m th t wh n tw l th nimals prepare f battle th y kneel dow with th h ads between tl f l gs, and in this atti t d th h rn tan f ly parall l and cl t tl gro d w tl tl points d ected fo w d l l ttl p ard The combatants

th f l g d to b g tl points f th h rns f rw rd h w uld g lly be und gre t disad ant g wh ttacked by any th animal It th ref re n t p b bl

see that, as soo as som ance t mal p g nto f the Oryx acq ired mod t ly lo g h ns, directed l ttl backw rds, h w ld b compelled hı b ttl w th n al mal s, to be d h h ad som wh t w rd d nwards, as w d by certain tag and t not mp b bl th t h ght h acqu red th hab t f t first occas nally nd aft rward f gularly kneeling d w In thi case t alm l certain tl t th mal which possessed tl l g t h rns w ld ha had gre t ad ant g tl w th sl t horns and tl n th h rns w ld grad lly ha bee re d red l g and lo g thro gh se al select til th y acq red th s- t traordinary l gth and po ti n.

With st gs f many k nds the branches of t ff rı s ase f d ffi ulty f r

thirty
fiftee ag r b an h and t M ritzbu g th t st ll pr se ed a pair of antlers f a red-dee h t ın 1699 by Fred nck I n of wl h b ars th ast nish g numbe f thı ty tl r b an h s and tl e oth twe ty se en maki g alt g the xty b anches Ricl ardson figure pai f antl f th wild reindee w th tw nty nın po ts [4] F m th mann which tl h n b anched and m pecially f m dee b g h wn occas onally to fight t g th by k li g w th th r f re f t [25] M Baılly t lly m s to the con fu n th t th ir h rns re m e inj ri u than useful to th m B t tl uth looks th p tched b ttl b tw n n al males \ I f lt much perpl ed ab t th us or ad ant ge f th b an h I ppl ed to M Mc N ill f C l say wl has l g and carefully b ed th h bı ts f ed-dee and h n f rm m th t l e has n een som of th b an hes b ght int se, b t that the brow antl f m m liming d wnwards, are a g at protection to th f head and th r po nts ar lik se sed m ttack S Phil p Eg rt n lso

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Sciences Nat., t m. n., 1824 p 371

well-developed tusks though not so large as those of the male

These differences in the tusks of the several races and species of elephants—the great variability of the horns of deer as notably in the wild reindeer—the occasional presence of horns in the female *Antilope bezoartica* and their frequent absence in the female of *Antilocapra americana*—the presence of two tusks in some few male narwhals—the complete absence of tusks in some female walruses—are all instances of the extreme variability of secondary sexual characters and of their liability to differ in closely allied forms

Although tusks and horns appear in all cases to have been primarily developed as sexual weapons they oft [illegible] pur [illegible] king [illegible] the [illegible] own [illegible] likewise thus extracts the farinaceous cores of palms in Africa he often uses one tusk always the same to probe the ground and thus ascertain whether it will bear his weight The common bull defends the herd with his horns and the elk in Sweden has been known according to Lloyd to strike a wolf dead with a single blow of his great horns Many similar facts could be given One of the most curious secondary uses to which the horns of an animal may be occasionally put is that observed by Captain Hutton[21] with the wild goat (*Capra aegagrus*) of the Himalayas and as it is also said with the ibex namely that when the male accidentally falls from a height he bends inwards his head and by alighting on his massive horns breaks the shock The female cannot thus use her horns, which are smaller but from her more quiet disposition she does not need this strange kind of shield so much

Each male animal uses his weapons in his own peculiar fashion The common ram makes a charge and butts with such force with the bases of his horns that I have seen a powerful man knocked over like a child Goats and certain species of sheep for instance the *Ovis cycloceros* of Afghanistan[22] rear on their hind legs and then not only butt but make a cut down and a jerk up with the ribbed front of their scimitar shaped horns as with a sabre When the *O cycloceros* attacked a large domestic ram who was a noted bruiser he conquered him by the sheer novelty of his mode of fighting always closing at once with his adversary and catching him across the face and nose with a sharp drawing jerk of the head and then bounding out of the way before the blow could be returned In Pembrokeshire a male goat the master of a flock which during several generations had run wild was known to have killed several males in single combat this goat possessed enormous horns measuring thirty nine inches in a straight line from tip to tip. The common bull as every one knows, gores and tosses his opponent but the Italian buffalo is said never to use his horns he gives a tremendous blow with his convex forehead and then tramples on his fallen enemy with his knees—an instinct which the common bull does not possess[23] Hence a dog who pins a buffalo by the nose is immediately crushed We must however rem [illegible] horns Mr Bartlett informs me that when a female Cape buffalo (*Bubalus caffer*) was turned into an enclosure with a bull of the same species she attacked him and he in return pushed her about with great violence But it was manifest to Mr Bartlett that had [illegible] short hair-covered horns, which are rather longer in the male than in the female in a curious manner for with his long neck he swings his head to either side almost upside down with such force [illegible] they can possibly use their curiously shaped horns thus the springbok (*Ant euchore*) has rather short upright horns, with the sharp points bent inwards almost at right angles so as to face each other Mr Bartlett does not know how they are used but suggests that they would inflict a fearful wound down each side of the face of an antagonist The slightly-curved horns of the *Oryx leucoryx* (fig 63) are directed backwards and are of such length that their points reach beyond the middle of the back, over which they extend in almost parallel lines Thus they seem singularly ill fitted for fighting but Mr Bartlett

[21] *Calcutta Journal of Nat. Hist.* vol. ii 1843 p 526

[22] Mr Blyth *Land and Water* March 1867 p 134 on the authority of Capt. Hutton and others. For the wild Pembrokeshire goats, see the *Field*, 1869 p. 150.

[23] M E. M Bailly "Sur l'usage des cornes," &c., *Annal des Science Nat.*, tom. ii, 1824 p. 369

the
brot
ti ...

thus ad antag th p k h rn b cks are gau ing po th comm b ks, ar d m v m tim turel supersede tl m n th Mdiron dacks. Lod btedl th first p k l rn bu k as merely an accid t l fre k f n ture But his sp k horns g l im an ad anta a d nabled him t propag t h pecul arit H descendant h ving l k ad tag l a propa ted th peculiar ty n onstantl n creasing rat o, till th v are l wly wd g th antl red dee from th tl hab t. A rit e has w ll bjected t thi ac count by aski g wh if th mpl l rn are no so ad anta eo s, w th l anched antl rs of th pare t f rm er d el ped To this I can nly an w by remark g that a ew mod f ttack with n w w po m ght be gre t ad antag as sh wn by tl ase f th *Ovis cycloceros* wh thus co q ed a do mesti ram fam f hi figl t g pow Tho gh th b anched antlers of t g are w ll ad pted f fight g with hi ri als, and tl gh t might be an ad antag t th pro g l rned ari ty sl ly t acqui l n and bran hed l rns, if h had to fight nl w th tl m f the sam kind y t t by m ans f llow that branched h rns w ld b th be t fitted f co q ring foe diff re tl armed In th f re going ase f th *Ory le* co y t alm t

ward tl m k-dee d wnward w th seri us ffec ech th with

lat D F lco that th Ind ar l phant fights diff re t an according t he positi and rs t re f l t ks. Wh n tl are directed f rward and pward l abl t fling t g t gre t d tance— t said t thirty feet wh tl y are h rt and t rned d ward h d urs d

d nl to p n tl t g r to tl e grou d and in conseque ce i dang rou to tl e ri l r who is liable t be j ked off tl l wdal[16]

V ry f w n al quadrupeds possess weapons of two d tin t kind pec ally d pted f r figl ti g w th ri al m le Tl e m l muntjac deer (C rvul) l r offers an xcept as l e i pro ded witl l orns and exserted canine teeth B t we m y nf r f om what f ll that o e f m f we pon ha ft n bee replaced n the course f age by an tl e W th ruminants the de elopm nt of h rns g n rall tand n an ve se rel t n witl that f e en mod l ly de l ped can e teetl Tl u m l gua acoes, cl vrotains, and musk-dee ar l rnless, and th y l v f ll nt can s th se teeth be lways of sm ll ze n tl f males tl an n tl e mal s. Tl Cam lidæ ha e in add t n to tl ir true s. pai f an n haped incisors n thei pper j ws. Male deer and ant l pes, n tl tl l and possess h n and tl rarely l v an ne teetl and these wl n prese t are alwa s f mall size so that it s do btf l wl the tl y ar f any service n th ttl s. In *Antilope m t a* th ust o ly as rud m nts in th g mal disap pear g as l e grow ld and tl ey are al se t n th f mal t all ag but the femal f certain tl ant l pe and of ce ta n dee l been k wn occa. ally t xl b t rud m t f th se teeth.[17] Stall ns ha e mall can teeth which are tl qu te abse t r dim ntary in th m re b t tl ey d not ppe to be used figl ti g fo tall b te w tl tl ir incisors, and d n t open tl m this w l l k m ls and anacoes. Wl th ad lt m l po sesse anin w ffici nt whilst tl e f male l as tl r n m re rud m ts, w m y co l d th t th arl mal g nito of tl pec was pro ded w th ffici t ca s, which l a e bee partially transf rred to th f m les Tl red t f th teetl in th mal seems to ha f ll wed from som chang in thei man

16 Pallas, *Spicilegia Zoologica*, fasc. xiii, 1779 p

[17] Lamont, *Seasons with the Sea-Horse* 1861 p. 141

also Falco (*Pal nt M m nd V le* l 1868, p 5 6) ca nes adult f m l dee l ld males of th musk-dee tl ca es (P llas, *Spic Zoolog* fasc. xi 1779 p. 18) som tim grow t th le gth of three ches, hilst ld f males rudi m t projects scarc ly half inch abo the gums.

informs me both as to red-deer and fallow-deer that in fighting they suddenly dash together and getting their horns fixed against each other's bodies a desperate struggle ensues. When one is at last forced to yield and turn round the victor endeavours to plunge his brow antlers into his defeated foe. It thus appears that the upper branches are used chiefly or exclusively for pushing and fencing. Nevertheless in some species the upper branches are used as weapons of offence: when a man was attacked by a wapiti deer (*Cervus canadensis*) in Judge Caton's park in Ottawa, and several men tried to rescue him, the stag never raised his head from the ground; in fact he kept his *face almost flat on the ground*, with his nose nearly between his fore feet, except when he rolled his head to one side to take a new observation preparatory to a plunge. In this position the ends of the horns were directed against his adversaries. In rolling his head he necessarily raised it somewhat, because his antlers were so long that he could not roll his head without raising them on one side, while on the other side they touched the ground. The stag by this procedure gradually drove the party of rescuers backwards to a distance of 150 or 200 feet; and the attacked man was killed.[6]

Although the horns of stags are efficient weapons, there can, I think, be no doubt that a single point would have been much more dangerous than a branched antler; and Judge Caton, who has had large experience with deer, fully concurs in this conclusion. Nor do the branching horns, though highly important as a means of defence against rival stags, appear perfectly well adapted for this purpose, as they are liable to become interlocked. The suspicion has therefore crossed my mind that they may serve in part as ornaments. That the branched antlers of stags as well as the elegant lyrated horns of certain antelopes, with their graceful double curvature (fig. 64), are ornamental in our eyes, no one will dispute. If, then, the horns, like the splendid accoutrements of the knights of old, add to the noble appearance of stags and antelopes, they may have been modified partly for this purpose, though mainly for actual service in battle; but I have no evidence in favour of this belief.

An interesting case has lately been published, from which it appears that the horns of a deer in one district in the United States are now being modified through sexual and natural selection. A writer in an excellent American journal[7] says that he has hunted for the last twenty-one years in the Adirondacks, where the *Cervus virginianus* abounds. About fourteen years ago he first heard of *spike-horn bucks*. These became from year to year more common; about five years ago he shot one, and afterwards another, and now they are frequently killed. The spike-horn differs greatly

FIG. 64. *Strepsiceros kudu* (from Sir Andrew Smith's *Zoology of South Africa*)

from the common antler of the *C. virginianus*. It consists of a single spike, more slender than the antler, and scarcely half so long, projecting forward from the brow, and terminating in a very sharp point. It gives a considerable advantage to its possessor over the common buck. Besides enabling him to run more swiftly through the thick woods and underbrush (every hunter knows that does and yearling bucks run much more rapidly than

[6] See a most interesting account in the Appendix to Hon. J. D. Caton's paper, before quoted.

[7] *The American Naturalist*, Dec. 1869, p. 552.

from various sources. F mal dogs, m sured t the sh ld r range from 8 nel es, hich is l w t n 34 nel s in l e ght and w ght from 80 po ds, wl el s l gl t, l e mo e. Th f m l s

poun
9 to 100 pound f r the mal and 0 for the f male, ould be saf b t th re reason to beli that f rm ly both sex s t tained gre te w ight. M C ppl l as ghed p pp es wh n f tnigl t ld in n l w lt f f mal

pe ce goe d g p pp as a rul d ii r ry l ttl from b tch t ll th y m e t bo t 6 six m ths ld and tl n th d g b gin to increase g ining po th b t l s b th m ght and size At b th and f se e l eeks aft rward b tel p ppy w ll occ

males d t tta n tl f ll growth t i t y ar ld th gh th f m l ttain t soo Accord g t M C ppl pen ence mal d g g grow g t t re t ll th are from tw l t ghtee m ths ld and ght till f m gl teen t t nty f ur mo ths ld whilst th f m les cease increasing t ture t th g f f m m t f rteen fiftee m ths, and ght t th a f from tw l to fifteen month From th se mo tat m t t l th t tl f ll diff re ce ze betw th m l and f mal Scot h dee l und t acq red t l th lat lif Th mal alm t lus ly are sed f co rsing f as M M N ill nf ms m th f males h t ffi t tre gth and w ght to pull d wn f ll gro n dee

From the name used in old legends, it appears as I hear f m Mr C pples th t t a v rs anci nt period th males we e th mo t cel l ated th e f mal s b i g ment oned only as th th r of fam us d gs. Hence during many gene at ns t is the mal wl ich l as be ch efly te ted f r tre gth ize peed and co ge and the b t w ll ha e be n bred and from f m As l we er the m l s do n t tta n the r full d men ons until r th r late n l f th y will ha tend d n accord ce with the law ft n i d c ted t tra m t th l a t rs to tl m l ff pring l ne and tl us th gre t qual ty b tween the sexes f the Scotch dee h und may probably be coo nted f

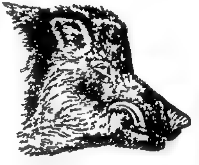

FIG. 63 H ad f comm n ild boar in prim f lif (from B hm)

The mal s f som f w q adrupeds poss s g n o p ts d l ped sol ly as m ans f d f ce gainst th ttacks f th m l s Som kind f dee use as w h e seen, th ppe bra ch f th h rns chi fly l ly f d f nding tl mselves and tl Oryx ant l pe as I am nf med by M Ba t l tt f nce m t kilf lly w th h lo g g ntly ed h rns but th se are l k wise sed as rg n f ff nce Th sam bserv remarks th t hi ocero n fight g parry ch oth s d l g bl ws w th th h rn l ch clatt l dly tog th as d th t ks f boars Alth gh wild boars fight d p t lv th y seld m accord g B hm rece f tal w unds as th bl w fall ach th tusks n th lay f gristly kin co ring th h ld lled by th G rman hunters th sh ld and h re w h p t pe lly modified f d f ce W th bo rs th p m f lif (see fig 6) th t ks in th l w y w are used fo fight g b t th y become in old g as Brehm t t s, so m ch rved ward

See also Richardso M al th D g p 59 Much aluabl f rm t th Scottish dee hound g en by M McN ill, I first alled t ten io t the equal ty size bet ee th se es, Scr pe Art of D er S alk g I h pe th t M C pples ill keep t h t t of p bl h g full ccou t nd history of this f us breed.

ner of fighting often (but not in the horse) caused by the development of new weapons

Tusks and horns are manifestly of high importance to their possessors for their development consumes much organised matter A single tusk of the Asiatic elephant—one of the extinct woolly species—and of the African elephant have been known to weigh respectively 1 0 1(0 and 180 pounds and even greater weights have been given by some authors [32] With deer in which the horns are periodically renewed the drain on the constitution must be great [illegible]

[illegible] —the skull of the latter weighing on an average only five pounds and a quarter Although the horns are not periodically renewed in sheep yet their development in the opinion of many agriculturists entails a sensible loss to the breeder Stags moreover in escaping from beasts of prey are loaded with an additional weight for the race and are greatly retarded in passing through a woody country The moose for instance with horns extending five and a half feet from tip to tip although so skilful in their use that he will not touch or break a twig when walking quietly cannot act so dexterously whilst rushing away from a pack of wolves During his progress he holds his nose up so as to lay the horns horizontally back and in this attitude cannot see the ground distinctly [34] The tips of the horns of the great Irish elk were actually eight feet apart! Whilst the horns are covered with velvet which lasts with red deer for about twelve weeks they are extremely sensitive to a blow so that in Germany the stags at this time somewhat change their habits and avoiding dense forests frequent young woods and low thickets [35] The [illegible] facts remind us that [illegible] birds have acquired ornamental plumes at the cost of retarded flight and other ornaments at the cost of some loss of power in their battles with rival males

With mammals when as is often the case the sexes differ in size the males are almost always larger and stronger I am informed by Mr Gould that this holds good in a marked manner with the marsupials of Australia, the males of which appear to continue growing until an unusually late age But the most extraordinary case is that of one of the seals (*Callorhinus ursinus*) a full grown female weighing less than one sixth of a full grown male [36] Dr Gill remarks that it is with the polygamous seals the males of which are well known to fight savagely together that the sexes differ much in size the monogamous species differing but little Whales also afford evidence of the relation existing between the pugnacity of the males and their large size compared with that of the female the males of the right whales do not fight together and they are not larger but rather smaller than their females on the other hand male sperm whales fight much together and their bodies are often found scarred with the imprint of their rivals teeth and they are double the size of the females The greater strength of the male as Hunter long ago remarked [37] is invariably displayed in those parts of the body which are brought into action in fighting with rival males—for instance in the massive neck of the bull Male quadrupeds are also more courageous and pugnacious than the females. There can be little doubt that these characters have been gained partly through sexual selection owing to a long series of victories by the stronger and more courageous males over the weaker and partly through the inherited effects of use It is probable that the successive variations in strength size and courage wh th [illegible] due to mere variability or to the effects of use by the accumulation of which male quadrupeds have acquired these characteristic qualities occurred rather late in life and were consequently to a large extent limited in their transmission to the same sex

From these considerations I was anxious to obtain information as to the Scotch deer hound the sexes of which differ more in size than those of any other breed (though blood hounds differ considerably) [illegible]

[illegible] with great kindness collected for me the following facts

[32] Emerson Tennent Ceylon 1859 [illegible] p. 275 O [illegible] British Fossil Mammals 1846 p. 245

[33] Richardson [illegible] Fauna Bor. [illegible] pp. 236 237 [illegible] of the horns, Land and Water 1869 p. 143 See also Owen British Fossil Mammals [illegible] 447 [illegible]

[35] Forest Creatures by C Boner 1861 p. 60

[36] See the very interesting paper by Mr J A Allen [illegible] Bull [illegible] Mus Comp Zoology of Cambridge [illegible] [illegible] Dr Gill [illegible] The [illegible] Nat [illegible] January 18[illegible] [illegible] whales [illegible] Nat [illegible] January 18[illegible]

[37] Animal Economy p. 45

scored and abraded in an e t aordinary man ner

Alth u h th males of so man members of the p g family are provided with w pons, and as ha just seen w th m ans f d fe ce these weapons seem to h e been acquired within a ath lat geological period D Forsyth M j spec fic se al m oc n species, in f whi h do th tusks ppear to ha been largely d l ped in the mal and Professor R tim yer was f rme ly struck with this sam fact.

F G. 67 Head of female Eth p w rt h g from P oc ed g f the Zoolog al Society 1869 h g th sam chara t rs as th male, though red ced scale.

N B Wh th gra g was first made, I was und th impress that t rep se ted th m le.

The mane of th l f a good def nce against the ttacks f al h ns, th dang to wh ch h habl f th mal s, as Sir A. Smith inf rm m n in te rибl b ttles, and y ung l dar n t pp ach an ld I 18 tig t Brompton h brok into th ca f h and fearf l see n

lynx (F l ca ad s) is m ch l ng in th mal than in th f m l b t wh th t serves as d f nce I d t kno Mal seals are w ll kn wn t fight desperately t g th nd th males of cert in kinds (Ot ria j bata) ha

gre t mane whilst the female have small nes or n ne. The mal baboon f the C pe of Good Hope (*Cynocephalus porcarius*) has a much longer mane and larg r canin teeth than the femal and th mane probably serves as protecti n, f r on aski g th keepers in the Zool g cal Gard n witho t giving them any cl e t my object, wh eth r any of the monkeys pecially ttacked each oth r by the n pe f th neck, I was answ red th t this was n t the case ept w th the abov baboon In the Hamadryas b boon, Ehrenberg com pares th mane f the ad lt male to that f a y ung lion, wh lst in the y ung f both sexes and in th e f male the mane is alm t absent.

It appe red to m p obable that the mm nse woolly man f th male American bison, which reaches lm t to th e ground, and is much more d l ped in the mal s than in th f males, erv ed as a protection to th m n the terr bl b ttl but an xperienced h te t ld J dg C ton that h had ne er ol served any th ng which fa ed thi beli f The stalli n has th ck r and full mane than the mare and I h made part cular inq ries f two gre t train rs and breeders, who h ve had ch rg f many ture horses, and am assured that they in ariably ndea r to seize anoth r by th neck. It does n t, h w f ll w from th f reg g tat m nts, that wh n th hair n th neck serv as a d fence that t was riginally d loped f this pur pose th gh this is probabl in some cases, as that f th h n. I am informed by M Mc N ll th t th l ng hairs n th throat f th tag (C rvus laph) serv as a great protec ti n t him wh n h nted f th do g n ally nd ur to seize him by th thro t b t t is n t prob bl th t th se hair w re pecially d l ped f this p rpose th rwise th y g and th f males w uld hav been eq ally p tected.

Choice i P n g by eithe S x f Q adrupe d —Bef re describ g in th next chapte the d ff rences between th se es ce

Ita della Soc It lia na di Sc Nat 1873, 1 fasc.

The T mes Nov 10 1857 In re ard t the C nada lynx, see Aud bo nd Bachman, *Quadrupeds f North A erica*, 1846, p 139.

D Murie, Baria, *Proc. Zoolog Soc* 1869 p 109 M J A. Allen, the paper abo q ted

(p. 75) d ubts heth th hair whi h is l ger the eck the mal tha in th f male, deserves to be called ma e.

and upwards over the snout that they can no longer be used in this way They may how ever still serve and even more effectively as a means of defence In compen at on f he loss those a little

laterally increase in old age so much in length and curve so much upwards that they can be used for attack Nevertheless an old boar is not o dangerous to man as one at the age of six or seven years [39]

In the full grown male Babirusa pig of Celebes (fig 66) the lower tusks are formidable weapons like those of the European boar in the prime of life whilst the upper tu ks are so long and have their points so much curled inwards sometimes even touching the forehead that they are utterly u e less as weapons of attack They more nearly resemble horns than teeth and are so manifestly useless as teeth that the animal was formerly supposed to rest his head by hooking them on to a branch! Their convex urface however if the head were held a little laterally would serve as an excellent guard and hence pe haps it is that in old animals they are generally broken off as if by fighting [40] Here then we have the curious case of the upper tusks of the Babirusa

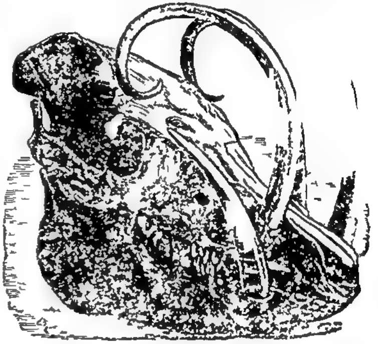

FIG 66 Skull f the Bab rusa I g (from W llace s Malay A h pel o).

the lower tusks assume in a less degree and only during old age nearly the same form and then serve in like manner solely for defence

In the wart hog (Phacochoerus aethiopicus fig 67) the tusks in the upper jaw of the male curve upwards during the prime of life and from being pointed serve as formidable weapons The tusks in the low r jaw are sharper than those in the upper but from their hortness it seems hardly poss ble that they can be used as weapons of attack. They mu t how ever greatly strength n those in the upper jaw from being ground so as to fit closely against their bases Neither the upper nor the lower tusks appear to have been pecially modified to act as guards, though no doubt they are to a certain extent used for th s pu pose But the wart hog is not de titute of other pecial means of protection for it has, on each side of the face beneath the eyes, a rather stiff yet flexible cartilaginous oblong pad (fig 67) which projects two or three inches outwards and it appeared to Mr Bartlett and myself when viewing the living animal, that these pads when struck from beneath by the tusks of an opponent would be turned upwards and would thus admirably protect the some hat prominent eye I may add on the authority of Mr Ba tlett that these boars when fighti g tan directly face to face

ans v rs to th fl xibl pad f the wart h g it has also two bo ny p m nences on the upper jaw above the no trils. A I ar of th s peci s in the Zool gic l Garden recently broke i t the cage of the wart h g They fought all n ght long, and were f und in the m rning much exh sted but n t se ously wounded It is a s gnif ca it fact, as sh ewing the purp ses of the above-described proj ctions and excrescences, that these were covered with blood and were

Brehm Th erl ben II ss. 729-32.

See Mr W llace t t rest g cco t of this animal, The Mal y Arch pelago, 1869 vol. i. p. 435

t and p l both f

more remarkabl case n whi h a

nd rf llv t llg t f male t n r l ed a retn r bel ging to a n ghbo t cl a degree that h had ft to be d gged w v from h m. Aft r th pe man nt sep t alth gh repe tedly h g milk in l te t she ld eve ackn wledg th co tsh p of any th d g and t the gret f l ow e ne r bo p pp es. Mr C ppl al t t s, that in 1868 f mal dee h d in l k l three prod ced p pp s, and n ach occas n shewed a marked pref re ce f f th l l most b t t tl most

th t he has kn wn som tances h ent th case f f his wn dee h ds, wh w ld not tak any n t ce f p rt cular f mal mast ff so that an th dee) d had t b mplo ed It ld b pe ff to gi as I could th instances, and I will ly add that M Barr h has caref lly bred many bloodhounds, tat th t in lm t rs in stance part lar d d ls f pposit se shew a decided pref re ce f ach th Finally M C ppl s, aft tt nding to tl subject f an th has wr tt to me, I ha had f ll co fi m t n f m f rm ' ar m t, th t d g b eed g f m decided pref rence f ach tl b g ft n fl ced b size bright col and d d l haract rs, as ll as b th d gre f th pre f mil arity

In regard to h rse M Bl nkiron, th gre test breed r f race l orses in the wo ld nf rm t l ll n are so f equently c p c and w th r ally used w uld e er nse n ly look t the nam o Glad ateu a d trick had t be practised W l al l ace l as t tl m m reject t rse

Mr W ght tabl so that tl mare had to be cl eated I ro per L cas[44] tes ariou tatem t from Fre l tl ti s, and re m ks *On t des ét lons q i ép e nent d' e j m nt t négl ge it t t les aut e* He gi e n the uth ts of B l n m lar fact n regard to bulls and M H Re ks as re m tl at a f m u l t l rn bull bel g t l f the n ari bly ref sed to b m t hed w tl black cow H ffb g in d sc b g tl l m t cated reindeer of L p-land ay *Fæ æ m j et f ri ma es pro cat rs dm it t d cos co f g nt a j toribus g tate q hos f gam on j ci nt* [45] A l g, m wh h s b ed many p gs, asserts th t sow ft n r ject e boar and ccmed t ly ccept an tl

From tl se facts th re an l do bt tl t w th m t f n d nest ted q adruped t g and d l antipathi s and prefe nces are f q tly xhib ted and much m com m nly by th f m l than by th male Th b ing tl cas t mprob bl that the un ns f q druped n a tat f nat re sh uld be l ft t m re ch ce It i mu h m prob bl tl t th f m l allu ed cited by p rt lar m l wh po sess ce t in ch act rs in high d g ee th n oth m l s but wh t th se ch act ar w an seldom r n disco w th certai ty

[44] T ité d l'Héréd. Nat. t m. 1850 p 296

[45] Amæ itate A ad l 1788 p 160

odours emitted and ornaments, it will be convenient here to consider whether the sexes exert any choice in their unions. Does the female prefer any particular male, either before or after the males may have fought together for supremacy; or does the male, when not a polygamist, select any particular female? The general impression amongst breeders seems to be that the male accepts any female; and this owing to his eagerness is, in most cases, probably the truth. Whether the female as a general rule indifferently accepts any male is much more doubtful. In the fourteenth chapter, on birds, a considerable body of direct and indirect evidence was advanced, shewing that the female selects her partner; and it would be a strange anomaly if female quadrupeds, which stand higher in the scale and have higher mental powers, did not generally, or at least often, exert some choice. The female could in most cases escape, if wooed by a male that did not please or excite her; and when pursued by several males, as commonly occurs, she would often have the opportunity, whilst they were fighting together, of escaping with some one male, or at least of temporarily pairing with him. This latter contingency has often been observed in Scotland with female red deer, as I am informed by Sir Philip Egerton and others.[4]

It is scarcely possible that much should be known about female quadrupeds in a state of nature making any choice in their marriage unions. The following curious details on the courtship of one of the eared seals (*Callorhinus ursinus*) are given[5] on the authority of Capt. Bryant, who had ample opportunities for observation. He says, "Many of the females on their arrival at the island where they breed appear desirous of returning to some particular male, and frequently climb the outlying rocks to overlook the rookeries, calling out and listening as if for a familiar voice. Then changing to another place they do the same again. . . . As soon as a female reaches the shore, the nearest male goes down to meet her, making meanwhile a noise like the clucking of a hen to her chickens. He bows to her and coaxes her until he gets between her and the water so that she cannot escape him. Then his manner changes, and with a harsh growl he drives her to a place in his harem. This continues until the lower row of harems is nearly full. Then the males higher up select the time when their more fortunate neighbours are off their guard to steal their wives. This they do by taking them in their mouths and lifting them over the heads of the other females, and carefully placing them in their own harem, carrying them as cats do their kittens. Those still higher up pursue the same method until the whole space is occupied. Frequently a struggle ensues between two males for the possession of the same female, and both seizing her at once pull her in two or terribly lacerate her with their teeth. When the space is all filled, the old male walks around complacently reviewing his family, scolding those who crowd or disturb the others, and fiercely driving off all intruders. This surveillance always keeps him actively occupied."

As so little is known about the courtship of animals in a state of nature, I have endeavoured to discover how far our domesticated quadrupeds evince any choice in their unions. Dogs offer the best opportunity for observation, as they are carefully attended to and well understood. Many bree[illegible]

[illegible] them as they are known to be in other cases, where higher animals are concerned. Bitches are not always prudent in their loves, but are apt to fling themselves away on curs of low degree. If reared with a companion of vulgar appearance, there often springs up between the pair a devotion which no time can afterwards subdue. Passion, for such it really is, becomes of a more than romantic endurance." Mr. Mayhew, who attended chiefly to the smaller breeds, is convinced that the females are strongly attracted by males of a large size.[6] The well-known veterinary Blaine states that his own female pug dog became so attached to a spaniel, and a female setter to a cur, that in neither case would they pair with a dog of their own breed until several weeks had elapsed. Two similar and trustworthy accounts have been given me in regard

[4] Mr. Boner, in his excellent description of the habits of the red-deer in Germany ('Forest Creatures,' 1861, p. 81) says, "[illegible] ... the sanctuary of his harem, and carries off trophy after trophy." Exactly the same thing occurs with seals; see Mr. J. A. Allen, ibid. p. 100.

[5] Mr. J. A. Allen in 'Bull. Mus. Comp. Zoolog. of Cambridge, United States,' vol. ii. No. 1, p. 99.

[6] 'Dogs: their Management,' by E. Mayhew, M.R.C.V.S., 2nd edit., 1864, pp. 187-192.

[7] Quoted by Alex. Walker 'On Intermarriage,' 1838, p. 276; see also p. 244.

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C L M rt n, G neral Int od ctio to the Nat al History of M mm. A als, 1841 p 431
Naturg schichte der Sä g tier P gu y ll m ce O b ts, M ll lson, *P oc ed g f th Zoolog cal Society* 1873 p 241
1830, ss. 15 21

CHAPTER XVIII

SECONDARY SEXUAL CHARACTERS OF MAMMALS—*Continued*

QUADRUPEDS use their voices for various purposes, as a signal of danger, as a call from one member of a troop to another, or from the mother to her lost offspring, or from the latter for protection to their mother; but such uses need not here be considered. We are concerned only with the difference between the voices of the sexes, for instance between that of the lion and lioness, or of the bull and cow. Almost all male animals use their voices much more during the rutting season than at any other time; and some, as the giraffe and porcupine,[1] are said to be completely mute excepting at this season. As the throats (i.e. the larynx and thyroid bodies[2]) of stags periodically become enlarged at the beginning of the breeding-season, it might be thought that their powerful voices must be somehow of high importance to them; but this is very doubtful. From information given to me by two experienced observers, Mr. McNeill and Sir P. Egerton, it seems that young stags under three years old do not roar or bellow; and that the old ones begin bellowing at the commencement of the breeding-season, at first only occasionally and moderately, whilst they restlessly wander about in search of the females. Their battles are prefaced by loud and prolonged bellowing, but during the actual conflict they are silent. Animals of all kinds which habitually use their voices utter various noises under any strong emotion, as when enraged and preparing to fight; but this may merely be the result of nervous excitement, which leads to the spasmodic contraction of almost all the muscles of the body, as when a man grinds his teeth and clenches his fists in rage or agony. No doubt stags challenge each other to mortal combat by bellowing; but those with the more powerful voices, unless at the same time the stronger, better armed, and more courageous, would not gain any advantage over their rivals.

It is possible that the roaring of the lion may be of some service to him by striking terror into his adversary; for when enraged he likewise erects his mane and thus instinctively tries to make himself appear as terrible as possible. But it can hardly be supposed that the bellowing of the stag, even if it be of service to him in this way, can have been important enough to have led to the periodical enlargement of the throat. Some writers suggest that the bellowing serves as a call to the female; but the experienced observers above quoted inform me that female deer do not search for the male, though the males search eagerly for the females, as indeed might be expected from what we know of the habits of other male quadrupeds. The voice of the female, on the other hand, quickly brings to her one or more stags,[3] as is well known to the hunters who in wild countries imitate her cry. If we could believe that the male had the power to excite or allure the female by his voice, the periodical enlargement of his vocal organs would be intelligible on the principle of sexual selection, together with inheritance limited to the same sex and season; but we have no evidence in favour of this view. As the case stands, the loud voice of the stag during the breeding season does not seem to be of any special service to him, either during his courtship or battles, or in any other way. But may we not believe that the frequent use of the voice, under the strong excitement of love, jealousy, and rage, continued during many generations, may at last have produced an inherited effect on the vocal organs of the stag, as well as of other male animals? This appears to me, in our present state of knowledge, the most probable view.

The voice of the adult male gorilla is tremendous, and he is furnished with a laryngeal sack, as is the adult male orang. The gibbons rank among the noisiest of monkeys, and the Sumatra species (*Hylobates syndactylus*) is also furnished with an air sack; but Mr. Blyth, who has had opportunities for observation, does not believe that the male is noisier than the female. Hence, these latter monkeys probably use their voices as a mutual call; and this is certainly the case with some quadrupeds, for instance the beaver. Another gibbon, the

[1] Owen, *Anatomy of Vertebrates*, vol. iii, p. 585.
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Mr. Green, in *Journal of Linnean Society*, vol. x, Zoology, 1869, note p. 362.

arey re tl d l g n th mal tl an m the f m le an l w nd rf ll po e ful. These m nk y n warm w the mak the for ts reso d t m g and e m g th the l lmu g ce Th mal s begin

they d light tl d t y to xcel ach tl Wheth m t f th f go-ing m k l acq red th po f l ices rd to b t th ır rı als and harm the f male — wheth the ocal g ns

seems tl m t p b l l

I m y h m t t ry n s sexual peculiariti occ rrı g ı se ls, beca se th y ha bee pposed by som writ rs t ffect th ice Th se f tl m l se l pl t (*Macrorh us p bosc d*) becom tl lo g ted d rı g th breed ason, l an th b rected I th t t t som tım foot ın l th Il f m l t tl us pro ded t y p nod f l f Tl n al mak ld l oarse, gu gl se wl ch d bl at great distan e d b l edt l t gth ed b th bosc th f th f nal be g diff t. Le so co p re tl ect

prod ced far l ack and and rise t an t nal t se h ın l ght Tl hood lotl ed w tl h t l d m scular t can b nfl ted til t m tl an eq al th hol h ad ze Tl mal l rutting,

fight f n sly n the ce, and tl e r roaring s said to be som times so loud as to be heard f u mil s off When ttacked tl s likewise r ar r b ll n nd whe e er ı r tated the bladd r nflated and qui s Som natur alist b l tl t th oice s tl us strength ned b t ar s othe uses h be n as-s gned t tl e traordı ary tructure Mr R Brown tl ks tl it serv s as a prot ct n ag t acc le ts of all kind but thı ı n t p b bl f as I am ass ed by Mr Lam nt wh killed 600 f th se num l the hood s r dı uta y n th f m l s, and t ot de l ped n tl m l d ring y tl

Odo r —W tl some animals, as ıtl the ot u kuck of Am a, tl e ov rwl elm ng odo wl ı l they m t ppears to serve el h as l f nce W th l ew m ce (So e) botl se e poss ss abdo nal scent gland d tl can be l ttl d l t from th ject n f tl bodı by b rd d beasts of p tl t tl od p tecti r the l s, tl gland becom enlarged tl male d ng tl l eed g as In many tl er q druped tl glard ar f the sam n b th se s, l t th ı se are not k wn In tl pec e th glar ds confined to tl e mal s, o re more d el ped th n n the fe l

mal l pl nt nlarge, and m t a secret n l a g tro g m k y od Th mal s, and ar ly th f mal s, f m y ki ds of b ts h gl d d protr d bl sacks tu ted n ar pa t and t s b l ed tl t th se od rif ro

Th k ffiu m f th male goat w ll kn n and tl t of ce ta n mal d r ı d f lly tr d p rs t t. O th banks f tl Pl ta I percei ed tl ai tainted w th the od f tl mal *C rr mpe tris* t h lf

K L M rt n, *G neral Introd ctio to the Natural History of M mm. A mals* 1841 p. 431

Naturg schichte der S geth er ro P gu y 1830, ss. 13 21

hr m ce O bats, Mr D bso *Proce d g f th Zoological Society* 18 3 p 241

CHAPTER XVIII

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QUADRUPEDS use their voices for various purposes, as a signal of danger, as a call from one member of a troop to another, or from the mother to her lost offspring, or from the latter for protection to their mother; but such uses need not here be considered. We are concerned only with the difference between the voices of the sexes, for instance between that of the lion and lioness, or of the bull and cow. Almost all male animals use their voices much more during the rutting season than at any other time; and some, as the giraffe and porcupine,[1] are said to be completely mute excepting at this season. As the throats (i.e. the larynx and thyroid bodies[2]) of stags periodically become enlarged at the beginning of the breeding-season, it might be thought that their powerful voices must be somehow of high importance to them; but this is very doubtful. From information given to me by two experienced observers, Mr. McNeill and Sir P. Egerton, it seems that young stags under three years old do not roar or bellow; and that the old ones begin bellowing at the commencement of the breeding-season, at first only occasionally and moderately, whilst they restlessly wander about in search of the females. Their battles are prefaced by loud and prolonged bellowing, but during the actual conflict they are silent. Animals of all kinds which habitually use their voices utter various noises under any strong emotion, as when enraged and preparing to fight; but this may merely be the result of nervous excitement, which leads to the spasmodic contraction of almost all the muscles of the body, as when a man grinds his teeth and clenches his fists in rage or agony. No doubt stags challenge each other to mortal combat by bellowing; but those with the more powerful voices, unless at the same time the stronger, better armed, and more courageous, would not gain any advantage over their rivals.

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pends from th neck and pper hal e of the legs b t M Bartl tt does not b l e that this mantle is of th l ast se t tl e m l m hom t s m ch m re d l ped th n in the f male

Male quadrupeds of many kind d ff r from the femal in havin more l air r l air f a diff re t charact on certain part f th r faces. Thus th b ll al n has cu led hai n the foreh ad[13] In three l sely lled ub g ne f th goat family nly tl mal possess beards som t m f lar in two ther b-g a both sex s ha a b ard but of l r ab t the face and h ad are alike in both sexes.

Tl e mal s f arıou membe s f th ox famıl (B dæ) and of certain ant l pes, are f rnısl ed w tl d l p or g eat fold of skin on tl neck wh ch is much less de eloped in tl female

N w tos h p te r tl e u w p l g th b k f certa n m l antelopes, are f any use t tl em in tl ır rdinary l ab ts. It s poss ble th t the immens beard of the m le P thecia an l th larg beard f th mal o ang m y protect tl t throats wh n figl ting f r th keeper n tl Zool gical Gardens ı f m m tl t n ar monk y ttack h tl by tl e thro t b t t n t prob ble that th b ard l as been d l ped fo a d t t p rpose from tl at served by th whisk rs m us tacl e and tl e t fts of l a n tl face and no n w ll ppose tl t tl ese are usef l as a protect n Mu t we at tribut ll th se ppend g of ha lunt m re p rpos l ss ari b l ty in th male It an n t b l n ed tl t this is po bl f mar y d m t cated q adrupeds, ce t n cl aract rs, ppare tl n t d ri ed througl re rs f m an w ld pare t f rm confi ed t th m l s, are m re l l ped n th m than in tl f males—f t ce tl h n p n the mal b e ttl f Ind th tail f f t t led ams, th arcl ed tl f tl f rel d tl m l f se l breed f heep d lastly tl m n th l g l rs th l d l s, and th d w l p f th m l f th B bu goat.[15] The m wh l occu only th am f an M an breed f heep tru seco d y se ual l act f as I h ar from M W wood Read t n t d l ped if th an mal b cas t ted Alth gl we ht t b tr m ly as l wn in my w k l rıat n

F 68 *Pith cı at as m le* (from Brehm)

rud m tar W th so k tl b rd is u f ed t tl mal as tl m l larg tl l tl tl f l as tl *Mycete* y and *I tl* t as (fi 68) So t th tl h k rs f som pe ıes l Macac s, and a ha seer w th th man f som pec f b boons. B t tl m t k d of m nk tl rrou t ft

[13] H ter *F say nd Observ t* as ed ted by O n 1861 ol. p 236

[14] See D Gray *Catalogue f M mmal the B ish M seum*, part iii., 1852, p. 144

[15] R ngger S *gethiere* &c., s. 14 Desmarest, *M mmalogie* p 66

[16] See th h pt rs th se eral mals l. of my *I at f A mal nder D m tıcatio* also ol 3 lso h p th p tice f select by sem -cı lised people. F th B buar goat, see D Gray *Cat log bid.* p. 157

mile to leeward of a herd and a silk handkerchief in which I carried home a skin though often used and washed retained when first unfolded traces of the odour for one year and seven months This animal does not emit its strong odour until more than a year old and if castrated whilst young never emits it.[10] Besides the general odour ole

Bos

er

p an 1 goats possess odoriferous glands in various situations more especially on their faces The so-called tear sacks, or suborbital pits come under this head These glands secrete a semi fluid fetid matter which is sometimes so copious as to stain the whole face as I have myself seen in an antelope They are usually larger in the male than in the female and their development is checked by castration [11] According to Desmarest they are altogether absent in the female of *Antilope subgutturosa* Hence there can be no doubt that they stand in close relation with the reproductive functions They are also sometimes present, and sometimes absent, in nearly allied forms In the adult male musk-deer (*Moschus moschiferus*) a naked space round the tail is bedewed with an odoriferous fluid whilst in the adult female and in the male until two years old this space is covered with hair and is not odorifero [11]

is a singular fact that the matter secreted by this latter gland does not, according to Pallas change in consistence or increase in quantity

at

ie

duction He gives, however only a conjectural and unsatisfactory explanation of its use

In most cases when only the male emits a strong odour during the breeding season it probably serv to excite o allure the female We must not judge on this head by our own taste for it is well kno e enticed

th er on

e some

by certain essential oils, and cats by val substances far from agreeable to us and dogs, though they will not eat carrion, and roll on it From the reasons given discussing the voice of the stag we may the idea that the odour serves to bring th males from a distance to the males. Active long-continued use cannot here have co into play as in the case of the vocal orga The odour emitted must be of considera importance to the male inasmuch as large a complex glands, furnished with muscles f everting the sack and for closing or openi the orifice have in some cases been develope The development of these organs is intell gible through sexual selection if the mo odoriferous males are the most successful winning the females, and in leaving off print to inherit their gradually perfected glands and odours.

Development of the Hair —We have seen that male quadrupeds often have the hair on their necks and shoulders much more developed than the females and many additional instances could be given This sometimes serves as a defence to the male during his battles but whether the hair in most cases has been specially developed for this purpose is very doubtful We may feel almost certain that this is not the case when only a thin and narrow crest runs along the back for a crest of this kind would afford scarcely any protection and the ridge of the back is not a place likely to be injured nevertheless such crests are sometimes confined to the males, or are much more developed in them than in the females. Two antelopes, the *Tragelaphus scriptus* [1] (see fig 0 p 556) and *Portax picta* may be given as instances. When stags and the males of the wild goat are enraged or terrified the crests stand erect but it cannot be supposed that they have been developed merely for the sake of exciting fear in their enemies. One of the above-named antelopes, the *Portax picta*, has a large well-defined brush of black hair on the throat, and this is much larger in the male than in the female In the *Ammotragus tragelaphus* of North Africa, a member of the sheep-family the fore-legs are almost concealed by an extraordinary growth of hair which de-

to y f l t brat L p 632.

See Is Dr Mu e s ob rvat s o th se gla d n th *Proc Zool g Soc* 1s p 340 Desmarest. On th *Antilope s bg tt osa*, *M mmal g* 1820 455

[11] Pallas, *Sp cil g Zoolog* f sc. x 1 9 p. 24 Desm ulins, *D ct. Clas d Hist. Nat.* t m p 586

D Gray *Gle g f m th M nagerie t Know l y* pl. 28.

J lg Cat th wapiti, *T ans ct. Ottaw A d N t. S ce* 1868, pp 36 40 Blyth, *Land and W at n C l ag g us*, 186 p. 37

brown shad abo e whilst the femal who ac quires her adult tints arlier in life than the male, is dark gre abo e, the ung of both sexes being of a deep chocolate colour The male of the north rn *Phoca groenland ca* is a grey with a curious saddle-shaped dark mark on the back th f mal is much smalle

pure white, and can hardl be distinguished among the icy hummocks and sn w their col our thus acting as protection.

With ruminants sexual diff rence of colour occur more commonly than in any oth r rd r

on the throat, th white marks n th f ttocks, and the black spots n th ars all much more

fact, as vid nce that the colouring of the *Portax* is of sexual origin, becomes ob io s, when we hear that ne th th red summ coat nor the blue wi t -coat of th Virginian deer is at all affected b emasculation. W th most or all of the highl orname ted species of Tragelaphus the males are darker than th hornless females, and their crests of hair are more fully dev loped In the mal of that magnificent ant lope, th D rb an eland th b l is redde the whole neck much blacke and the white band which separates these col ours broad than in th f male In th C pe land also the male is sl htl dark than the female

In the Indian black buck (*A bezoartica*) which bel ngs t an the tribe of antelopes th mal is ry dark, almo t black whilst the h rnless f male is f wn-coloured W meet in this pecies, as Mr Bl th inform me, with an exactly similar seri of facts, as in the *Portax picta* namely in the male period call chang ing col u durin th breeding season, in the effects f masculati n on this change and in the young of both sexe being indistinguish able from ach th In the *Antilope n ger* the male is black, th f male, as well as th oun of both se es, being brown in A s g n g th male is much bright r coloured than the horn less f male and his chest and bell are blacker th m l A caama, the marks and lines

mal are nearly the sam as th se of th fe male onl deepe and f a brighter h Oth anal us cases could be added

Th banteng bull (*Bos d cus*) of the Malayan Archipelago is alm t black, with whit l gs and b ttocks th cow is of a bright dun, as are th ung males until bout th age f three ears, when th y p dly change colour The masculated bull re rts to the colou of th f mal Th f mal kemas goat is pal and both t and the f male *Capra ag grus* are said to be mo unif rmly tinted than th mal s Dee rarely present an sexual diff rences in colour J dg Caton, h w uf rms m that in th males of th w pati dee (*Cerv adensis*) th neck, bell and legs are much dark than in th fe mal b t d rin th w nt the darke tints graduall fad an and disappear I may here mention that Judg Caton has in his park three races of th Virginian dee which diff in sl htl in colour b t th diff rences are al most exclus l confined to th bl winte o breeding-coat so that this case may be com pared with those g n in a pre us hapt I losel al ed rep esentati species f birds, which diff from each th only in

Dr Mur the Otaria, *Proceed g Zoological Society*, 1869 p 1 Mr B Bro n the P

Menagerie f Knowsley. In which there is splendid dra ng of the Oreas derbia se see the text Tra

gelaphus. For the C pe land (*O as canna*), see Andrew Smith, *Zoology f S Africa*, pls. 41 d 42. There are lso ma y of these telopes in th Zoological Gardens.

[30] the A ger see *P c Zool. Soc* 1850 p 133 W th respect t alued species, hich ther is equal sexual difference colour see Sir Baker *The Albert Ny n a*, 1866 ol. ii., p. 627 For the A n g n g Gray *Cat. B Mus* p 100 Desmarest. *M mmalogie* p. 463, th A caama. Andrew Smith, *Zoology of S Africa*, n th gnu.

under Domestication in concluding that any character even with animals kept by semi civilised people has not been subjected to selection by man and thus augmented yet in the cases just specified this is improbable more especially as the characters are confined to the males or are more strongly developed in them than in the females If it were positively known that the above African ram is a descendant of the same primitive stock as the other breeds of sheep and if the Berbura male goat with his mane dewlap &c is descended from the same stock as other goats then assuming that selection has not been applied to these characters they must be due to simple variability together with sexually limited inheritance

Hence it appears reasonable to extend this same view to all analogous cases with animals in a state of nature Nevertheless I cannot persuade myself that it generally holds good as in the case of the extraordinary development of hair on the throat and fore legs of the male Ammotragus or in that of the immense beard of the male Pithecia Such study as I have been able to give to nature makes me believe that parts or organs which are highly developed were acquired at some period for a special purpose With those antelopes in which the adult male is more strongly coloured than the female and with those monkeys in which the hair on the face is elegantly arranged and coloured in a diversified manner it seems probable that the crests and tufts of hair were gained as ornaments ...

... doubtful

Colour of the Hair and of the Naked Skin —I will first give briefly all the cases known to me of male quadrupeds differing in colour from the females With marsupials as I am informed by Mr Gould the ... er ... o ... g ... e ... are red [1] In the *Didelphis opossum* of Cayenne the female is said to be a little more red than the male Of the rodents Dr Gray remarks African squirrels especially those found in the tropical region have the fur much brighter and more vivid at some seasons of the year than at others, and the fur of the male is generally brighter than that of the female [20] Dr Gray informs me that he specified the African squirrels because from their unusually bright colours they best exhibit this difference The female of the *Mus minutus* of Russia is of a paler and dirtier tint than the male In a large number of bats the fur of the male is lighter than in the female [21] Mr Dobson also remarks with respect to these animals Differences depending partly or entirely on the possession by the male of fur of a much more brilliant hue or distinguished by different markings or by the greater length of certain portions are met only to any appreciable extent in the frugivorous bats in which the sense of sight is well developed This last remark deserves attention as bearing on the question whether bright colours are serviceable to male animals from being ornamental In one genus of sloths it is now established as Dr Gray states that the males are ornamented differently from the females—that is to say that they have a patch of soft short hair between the shoulders which is generally of a more or less orange colour and in one species pure white The females on the contrary are destitute of this mark

The terrestrial Carnivora and Insectivora rarely exhibit sexual differences of any kind including colour The ocelot (*Felis pardalis*) however is exceptional for the colours of the female compared with those of the male are *moins apparentes le fauve étant plus terne le blanc moins pur les raies ayant moins de largeur et les taches moins de diamètre* [22] The sexes of the allied *F lis mitis* also differ but in a less degree the general hues of the female being rather paler than in the male with the spots less black The marine Carnivora or seals on the other hand sometimes differ considerably in colour and they present as we have already seen other remarkable sexual differences Thus the male of the *Otaria nigrescens* of the southern hemisphere is of a rich

[1] *Osphranter rufus* Gould *Mammals of Australia* 1863 vol ii On the Didelphis Desmarest, *Mammalogie* p 256

... *Mag* ... *of Nat Hist* ... 1867 p 325 On the Mus minutus Desmarest *Mammalogie* p 304

... *mp Zool* ... M Dobson ... *Zoolog Soc* ... 1873 p 241 Dr Gray on ... 1871 p 436

[22] Desmarest *Mammalogie* 1820 p 220 On Felis mitis Rengger ibid s. 194

female ho ver th nose at certain gular
intervals of tim becomes ti ted with red

In all the cases hith rto gi en the mal is more strongly or bright col ured than th female, and differs from th young f both sexes. B t as with som f w birds t is th fe-male which is brighter coloured than th male so with th hesus m nkey (*Macacus he us*) the female has lar urface of naked skin round the tail, of brilliant carmin red, which, as I was assured by th keepers th Zoological Gard ns, periodically becomes n

Fig. 69 Head of male Mandrill (from Ger ais, Hist. Nat. d M mm fer)

et more id and b face also is pale red. On the othe hand, in th adult mal and the oung of both se (as I saw in th Gar dens) neithe the naked ki t the post rio end of the bod no th face sh w trace f red. It ppears, h w from some p blished accounts, that the male does occasionally during certain seasons, xh b t som traces of the red. Although he is thus less rnam nted than the female y t in th lar size of his body lar cani teeth more d loped hiskers, more promine t superciliary ridges, he follow th commo rule of th mal ex celling the female.

I hav n w gi n all the cases kn wn to m of a diff rence in colour betw een th sex s of mammals. Some of these may be th result of ariat ns confined to on sex and transmitted to the sam sex, with ut any good being gained and th refore w th ut the aid of selecti n W ha e instances of this with our domesticated animals, as in the males of certain cats being rusty red whilst th f males are tort ise l ll coloured. Analo us cases occu in nature M Bartl tt has seen man black ari t es of th jaguar leopard, vulpin phalang r and w mbat and h is ce tain that all, r n arly all these animals, were males. On the the hand with w l es, f es, and pparentl American squirrels, both sexe are occasionally born black. H nce t is quit possibl that w th

lim ted in th ir transmissio N erth less t is mprobable that tl d v rsified id, and co trasted col rs of certain quadrupeds, f instance f th abo monk s and ant lopes, can thus be accounted for W sh uld bear n mind that th se col rs do n t ppear th mal t birth, b t only t o n ar maturity and th t unl ke ordinary ariati ns, th y are lost if th mal be masculated. It is n the wh l probable that th trongly marked col rs and oth rname tal haracte of mal quadrupeds are be ficial to th m n their ri alry with th mal s, and ha conse q tl been acquired thro gh sexual selec tion. This vi w is stre gth ned by th diff ences in colour between th se es occurring almost xclusi ly as may be collected from th pre us d tail., th se gro ps and ub-gro ps f mammals which present th and stro gly marked secondary sexual characters these bei likewise du to sexual select n.

Quadrupeds manifestly take n tice f colour S S. Bake repeatedly observ ed that th African lephant and hinocero ttacked whit grey h rses with pecial fury I h lsewh re sh wn[20] th t half wild h rses ppar tly pref to pai with those of th sam colour and that h rds f fall w-dee of differ ent colours, tho gh li ing to th ha long kept distinct. It is more significant fact that f male zebra w uld n t admit th addresses f mal ass until h was painted so as to re-

[20] *The Variatio of A mals and Plants nder Domestication*, 1868, vol. ii., pp. 102, 103.

their breeding plumage.[27] The females of *Cervus paludosus* of S. America, as well as the young of both sexes, do not possess the black stripes on the nose and the blackish-brown line on the breast, which are characteristic of the adult males.[28] Lastly, as I am informed by Mr. Blyth, the mature male of the beautifully coloured and spotted axis deer is considerably darker than the female; and this hue the castrated male never acquires.

The last Order which we need consider is that of the primates. The male of the *Lemur macaco* is generally coal-black, whilst the female is brow

New World

cara ja are gr

in the second year the young male becomes reddish-brown; in the third, black, excepting the stomach, which however becomes quite black in the fourth or fifth year. There is also a strongly marked difference in colour between the sexes of *Mycetes seniculus* and *Cebus capucinus*; the young of the former, and I believe of the latter species, resembling the females. With *Pithecia leucocephala* the young likewise resemble the female, which are brownish-black above and light rusty-red beneath, the adult males being black. The ruff of hair round the face of *Ateles marginatus* is tinted yellow in the male and white in the female. Turning to the Old World, the males of *Hylobates hoolock* are always black, with the exception of a white band over the brows; the females vary from whity-brown to a dark tint mixed with black, but are never wholly black.[30] In the beautiful *Cercopithecus diana*, the head of the adult male is of an intense black, whilst that of the female is dark grey; in the former the fur between the thighs is of an elegant f

the sexes is that the tail of the male is chestnut and that of the female grey; but Mr. Bartlett informs me that all the hues become more pronounced in the male when adult, whilst in the female they remain as they were during youth. According to the coloured figures given by Solomon Muller, the male of *Semnopithecus chrysomelas* is nearly black, the female being pale brown. In the *Cercopithecus cynosurus* and *griseoviridis* one part of the body, which is confined to the male sex, is of the most brilliant blue or green, and contrasts strikingly with the naked skin on the hinder part of the body, which is vivid red.

Lastly, in the baboon family, the adult male of *Cynocephalus hamadryas* differs from the female not only by his immense mane, but slightly in the colour of the hair and of the naked callosities. In the drill (*C. leucophaeus*) the females and young are much paler-coloured, with less green, than the adult males. No other member in the whole class of mammals is coloured in so extraordinary a manner as the adult male mandrill (*C. mormon*). The

lue with

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the face

s also marked with whitish stripes, and is shaded in part with black, but the colours appear to be variable. On the forehead there is a crest of hair, and on the chin a yellow beard. "*Toutes les parties supérieures de leurs cuisses et le grand espace nu de leurs fesses sont également colorés du rouge le plus vif, avec un mélange de bleu qui ne manque réellement pas d'élégance.*"[1] When the animal is excited all the naked parts become much more vividly tinted. Several authors have used the strongest

fully developed, immense protuberances of bone are formed on each cheek, which are deeply furrowed longitudinally, and the naked skin over them is brilliantly-coloured, as just described (Fig. 69). In the adult females and in the young of both sexes these protuberances are scarcely perceptible; and the naked parts are much less bright coloured, the face being almost black, tinged with blue. In the adult

[27] *Ottawa Academy of Nat. Sc.* May 21, 1868, p. 3, 5.

[28] S. Müller ... *Zoog.* ... 1839-1844, tab. 3 ... quoted by Mr. Blyth in *Land and Water*, 1867.

[1] G... *Hist. Nat. des Mammifères*, 1824, p. 103. Figure ... skull of the male ... *Hist. Nat. des Mammifères*, 1824, t. ...

female, however, the nose at certain regular intervals of time becomes tinted with red.

In all the cases hitherto given the male is more strongly or brighter coloured than the female, and differs from the young of both sexes. But as with some few birds it is the female which is brighter coloured than the male, so with the rhesus monkey (*Macacus rhesus*) the female has a large surface of naked skin round the tail, of a brilliant carmine red, which, as I was assured by the keepers in the Zoological Gardens, periodically becomes even

FIG. 69. Head of male Mandrill. From Gervais, Hist. Nat. des Mammifères

yet more vivid, and her face also is pale red. On the other hand, in the adult male and in the young of both sexes (as I saw in the Gardens), neither the naked skin at the posterior end of the body, nor the face, shew a trace of red. It appears, however, from some published accounts, that the male does occasionally, or during certain seasons, exhibit some traces of the red. Although he is thus less ornamented than the female, yet in the larger size of his body, larger canine teeth, more developed whiskers, more prominent superciliary ridges, he follows the common rule of the male excelling the female.

I have now given all the cases known to me of a difference in colour between the sexes of mammals. Some of these may be the result of variations confined to one sex and transmitted to the same sex, without any good being gained, and therefore without the aid of selection. We have instances of this with our domesticated animals, as in the males of certain cats being rusty-red, whilst the females are tortoise-shell coloured. Analogous cases occur in nature. Mr. Bartlett has seen many black varieties of the jaguar, leopard, vulpine phalanger, and wombat; and he is certain that all, or nearly all these animals, were males. On the other hand, with wolves, foxes, and apparently American squirrels, both sexes are occasionally born black. Hence it is quite possible that with some mammals a difference in colour between the sexes, especially when this is congenital, may simply be the result, without the aid of selection, of the occurrence of one or more variations, which from the first were sexually limited in their transmission. Nevertheless it is improbable that the diversified, vivid, and contrasted colours of certain quadrupeds, for instance, of the above monkeys and antelopes, can thus be accounted for. We should bear in mind that these colours do not appear in the male at birth, but only at or near maturity; and that, unlike ordinary variations, they are lost if the male be emasculated. It is on the whole probable that the strongly-marked colours and other ornamental characters of male quadrupeds are beneficial to them in their rivalry with other males, and have consequently been acquired through sexual selection. This view is strengthened by the differences in colour between the sexes occurring almost exclusively, as may be collected from the previous details, in those groups and sub-groups of mammals which present other and strongly-marked secondary sexual characters; these being likewise due to sexual selection.

Quadrupeds manifestly take notice of colour. Sir S. Baker repeatedly observed that the African elephant and rhinoceros attacked white or grey horses with special fury. I have elsewhere shewn that half-wild horses apparently prefer to pair with those of the same colour, and that herds of fallow-deer of different colours, though living together, have long kept distinct. It is a more significant fact that a female zebra would not admit the addresses of a male ass until he was painted so as to re-

* *The Variation of Animals and Plants under Domestication*, 1868, vol. ii. pp. 102, 103.

semble a zebra, and then as John Hunter remarks she received him very readily In this curious fact we have instinct excited by mere colour which had so strong an effect as to get the better of everything else But the male did not require this the female being an animal somewhat similar to himself was sufficient to rouse him [33]

In an earlier chapter we have seen that the mental powers of the higher animals do not differ in kind though greatly in degree from the corresponding powers of man especially of the lower and barbarous races and it would appear that even the[i] ful id sh

n parallel ridges or cicatrices high above the natural surface which unsightly deformities are considered great personal attractions [34]—as negroes and savages in many parts of the world paint their faces with red blue white or black bars —so the male mandrill of Africa appears to have acquired his deeply furrowed and gaudily coloured face from having been thus rendered attractive to the female No doubt it is to us a most grotesque notion that the posterior end of the body should be colour d for the sake of ornament even more brilliantly than the face but this is not more strange than that the tails of many birds should l e (n l s

aims before the female and the elaborate manner in which this i performed by male birds and other animals is the strongest argument in favour of the belief that the females admire or are excited by the ornaments and colours displaye l before them There is however a striking parallelism between mammals and birds in all their secondary sexual characters namely in tl eir weapons for fighting with rival males in their ornamental appen lages and in tl eir colours In both classes when the male l ff

ses us and i masculated at an early period lo es tl em In both classes the change of colour is sometimes seasonal and the tints of the naked parts sometimes become more vivid during the act of courtship In both classes the male is almost always more vividly or strongly coloured than the female an l is ornamented with larger crests of hair or feathers or other such appendages In a few exceptional cases the female in both classes is more highly ornamented than the male With many mammals, and at least in the case of one bird the male is more odoriferous than the female In both classes the voice of the male is more powerful than that of the fem le Considering this parallelism there can be little doubt that the same c use whatever it may be has acted on mammals and birds and the result, as far as ornamental characters are concerned may be attributed as it appears to me to the long continued preference of the individuals of one sex for certain individuals of the oppo ite sex combined with their uccess in leavin a larger number of offspring to inherit their superior attractions

Equal transmission of ornamental characters to both sexes —With many birds ornaments, which analo y leads us to believe were primarily acquired by the males have been transmitted e ually or almost equally to both sexes and we may now enquire ho far this view applies to mammals With a considerable number of species e pecially of the smaller kinds both sexes have been coloured independently of sexual selection for the ake of protection but not as far as I can judge in so many cases nor in so st d s l

art i so complete as the resemblance H l are on her form is a familiar instance of conc alment thr ugh colour yet this principle partly fails in a clo ely allied pecies the rabbit for l er runnin to its burrow it is ma le con p cu to the portsman and no doubt to all l ast f prey by its upturned white tail No one doubts that the quadrupe Is inl abiting sno cla l regions have been rende ed white to protect tl em from their enemies or to favour their tealing on their prey In reg ons h e sno never lies for long a white coat ould l e injur ous consequently pecies of tl i col ur are xtremely rare in the hotter parts of th world It de-

[33] *Es a ys and Ob t t ns* by J H nt ed ted by O 1861 p 194

[34] S r S Bak *The N le Tribut s f Abysn* 1867

[35] *F b z beth cu* Audubo nd B hman, *The Q ad ped f N th Am ric* 1846 p 109

serves notice that man quadrupeds nhab ting moderately cold regions, alth h th do n t assume hite wint dress, becom pal r d— this season and thus ppare tl is the direct result of th conditi s to wh h th have long bee exposed Pallas[28] tates th t in Siberia chang of tl nat re occurs with tl e wolf, t species of Mu t la, tl e domestic horse, the Eq us hem us the d m t c cow t species of antelopes, th musk-dee th roe, elk, and reindeer Th roe f in tance has red summer and greyish white wi t coat and the latt ma perhaps serv as protectio to th animal whilst wand ri g through the leafless thi k ts, spri kled w th snow and hoar frost. If the abo e-named ani mals ere grad ally t ext nd tl rang to regions perpetually co red w th sn w tl en

brown piebald rabb ts in large walled o chard and he had t the sam tim some similarl coloured cats hi house. S ch cats, as I have often noticed, are re con p cuou during da b t as th used to l w tch during the dusk t th m th f tl b rrows, the rabb ts pparentl did n t di tingu sh them from thi parti-col red brethren. Th result was that, thin hteen mo ths, ry one of these part -colo red rabb ts was d stro ed and there was d nce that this was effected b th cats. Colo seems to be ad anta eous t an th animal, th kunk, in manner of which w ha had man instances in ther cla ses. N animal will oluntaril attack one of these creat res eco t of th dreadful odour which t mits wl rrit ted b t during th du k t w uld not asil be recognized and might be ttacked l bea t of prey Hence t is, as Mr B lt beli es,[37] that the skunk is pro ded witl great wh t bushy tail, which serves as con p us arning.

Altho gh w must admit that man quad rupeds ha rece ed their prese t tint ther as protection, as an aid procuring pre yet with host of spec es, th colours are far too conspicuo and too ngularl arranged to allow us to s ppose that tl serv f r tl ese purposes. We ma take as an illustration cer tain antel pes wh n we see the square wl ite patch on the throat, the white marks on the f tlocks, and th round black pots on tl ars, all m re d t nct n tl e mal of the P rtax picta, than n the f male —wl n w see that th colours are more i nd that the narrow wh t l es n th flank and th broad wl t bar n the sl ulde are m re dist nct n the male Oreas derby nus than n tl e f male — wh n w see similar d ff re ce between tl e sexes of th curi d -ornam nted Tra l phus scriptus (fig 0) —w can t bel th t diff rences of thi kind are of an ser ce to th se in th ir dail habits of life. It seem a much m re probabl co clus n that the ari u marks w re first acq ired l y tl e males and tl ir colo rs i t nsified thro gh sexual select n, and then partiall transf rred to th f males. If tl is i w be admitted, tl re can be littl doubt that tl equall singular colo rs and marks of many otl ant l pes, tl o gh commo to both se es, h e been gained and transm tted in a l k mann Both se es, f in tance f the koodoo (trepsi eros kud) (fig 64) ha narrow wh t t cal li es n th ir hind flanks, and an l g t angular whit mark th f rel ads. B th se n tl ge u Damalis are y oddly colo red in D g th back and neck are purplish red

larg bl g wl t ma k, narrowly-edged w th black, co rs th face up to th (fig 71) th re are three wl t tripes n th f reh ad and th ear are marked w th whit The f wns of thi peci are of unif rm pale llow sh brown. I Damalis alb frons th col rin f th l ad diff rs from that n th last pecies a si gl whit tripe replacing the three tripes, nd in th ars being almost h ll white.[38] Aft r ha in studied t th best of my ability tl sexual diff rences of ani mals belo ging to all classes, I cannot I th conclu n th t th curi usl arranged col urs f many ant l pes, th h common to both se es, are th result of se ual select on primarily pplied t tl male.

Th sam co clusi m pe hap be tended to th tig on of th most beautiful

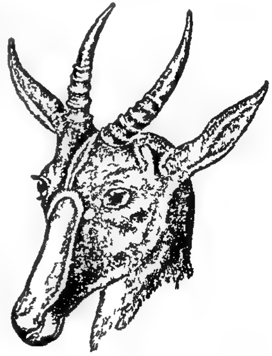
[36] Nova species Quadruped m Glir m ordine 1778, p. What I ha e called the roe is the C preo lus sibiricus subecaudatus of Pallas.

[37] The Naturalist in Nicaragua, p. 249

[38] See the fine plate in A. Smith Zoology of South Africa, nd D Gray Glean g from the Menagerie of Knowsley

FIG 70 T gel phu cr iptu male (from the Know ley M nagerie)

animals in the world the sexes of which cannot be distinguished by colour even by the dealers in wild beasts Mr Wallace believes[39] that the striped coat of the tiger so assimilates with the vertical stems of the bamboo as to assist greatly in concealing him from his approaching prey But this view does not appear to me satisfactory We have some slight evidence that his beauty may be due to sexual selection for in two pecies of Felis the analogous marks and colours are rather brighter in the male than in the female The zebra is conspicuously striped and stripes cannot afford any protection in the open plains of South Africa Burchell[40] in describing a herd says their sleek ribs glistened in the sun and the brightness and regularity of their striped coats presented a picture of extraordinary beauty in which probably they are not surpassed by any other quadruped But as throughout the whole group of the Equidæ the sexes are identical in colour we have here no evidence of sexual



Fi 71 D m l pyg ga, male (from the Know le, M nagerie)

[39] *Westminster Review* July 1 1867 p 5
[40] *Tr v l n S th Africa* 1824 vol ii p 315

xtend th sam v ew to the oyal tig r and bea tiful zebra.

m hapter tl t wl en

1

y g ar mark d w th l ngi u and th s diff from all tl x ti g ad lt spe un tl se t g W tl m y ki d f dee th y g m ked w tl l gant l te pots, f hi h tl p re t b b t n t t ac A grad ted n can be f ll wed f m th xi dee b tl sex f wl cl at all ages and d n ll aso s b autif lly potted (th mal b g tl m t gly col ed t y nec m wh l n th t

d g th mm wh n tl g l co th co t is l ght tl an d n g tl w t wh th ral l is d k and the l

is eddi l b wn b t qu t disappe r dur g th nte whe th co t b w I both th se pec th y g ar potted In th d th y u g l k w se potted

hi h are alw y th m in n mb s l y n bl n d t n t From ll con d t tl b t y m ll t p to th compl t abse ce f spots tl ad lts t ll seasons d lastly to th bsen t ll ages and seasons as occurs w th rtai pe ci s. F m th xiste f this perfect se s, and m pecially f m th f wns f so man peci b g potted may co cl d th t tl now l g m mb rs f th dee family ar th d sce dants f som n t pe ie hi h, l k th axis dee was potted t all

ges and seasons A till more ancient prog ni tor pr b bly som wl t resembled th *Hy m s l us aq t c s*—f r tl s an mal is potted an l the lo l ss m l s l e la ge exserted c m t tl f li l so e f w tru deer t ll r ta n rud nt Hy n sel s lso ff s se f f m l nk ng o to cer pac m ly tl o gl t to be q t d t t

A d ffi ulty l r rises If we admit tl t col l pot d tripes were f r t ac ju d as rna ts, l w com th t so m y xi t ng l r tl d sce d ts f an b ginally potted animal and all tl pe f p gs a l t tl e descendants f an abo gi ally tr ped a m l l a e l t n tl r ad lt t te tl r f rme nam nts I cann t t fact ly w r tl ju t n W m y feel alm tl t th pot an l tr pe dis ppeared t r m t nty in tl pr g to f x t g pecı so th t tl y we e t ll t ed by th y u g nd ow g to th l w f l ritance t corre po d g g s, w re t nsm tted to th y g f all ucceed g g n t n It m y h been a great ad ntag to th l n a d p ma, fr tl e pen nat f th ll ts to l e l t tl r t pe d to h bee tl r nd ed l ss consp cu to tl p y and f tl e cce e n h by whi h tl s nd was gai ed oc ed tl l te n l f th y g wo ld l tai ed tl r t pes as n w tl case As t d p gs, d tap rs, F tz Müll r l as t l to m tl t these anim l by tl e

b th tru plan t b t t the tr ge th t tl y g h ld t h e b thus p o tected nd t ll m re so that th ad lts f som pec ho ld ha ret d ther p ts, th part lly compl tely d n g part f th year W know th t wl n th d me t ass a and becom edd h b wn, g y black, th trip n th l lde and e n n th p f q tly disappear though we cann t pla th cause V y f w h se cept dun-c l ed k nd h tripes n any p rt f th ir bod y t w h good ason

D Gray *Gle g f m the M nagerie f Knowsley* p M Blyth, peaki g (*Land nd Water* 1869 p 42) of th h g-dee f C yl n, y t is mo b ghtly potted th hut tha th comm h g deer t th seaso he t ts h rns.

Falco nd C tl y *P oc Geolog Soc* 1843 nd Falco er *Pal Memoi* l. i., p 196

FIG 70 *Tr g laph s scriptus* male (from the K ow ley Menagerie)

animals in the world the sexes of which cannot be distinguished by colour even by the dealers in wild beasts Mr Wallace believes[39] that the striped coat of the tiger so assimilates with the vertical stems of the bamboo as to assist greatly in concealing him from his approaching prey But this view does not appear to me satisfactory We have some slight evidence that his beauty may be due to sexual selection for in two pecies of Felis the analogous marks and colours are rather brighter in the male than in the female The zebra is conspicuously striped and stripes cannot afford any protection in the open plains of South Africa Burchell[40] in describing a herd says their sleek ribs glistened in the sun and the brightness and regularity of their striped coats presented a picture of extraordinary beauty in which probably they are not surpassed by any other quadruped But as throughout the whole group of the Equidæ the sexes are identical in colour we have here no evidence of sexual selection Nevertheless he who attribute the white and dark vertical stripes on the flanks of various antelopes to this process will probably

FIG 71 *D mal pyg ga*, male (from the K w ley M geri)

[39] *Westminster Review* July 1 1867 p 5
[40] *Travels in S th Af ic* 1824 v l ii p 315

Fig. 5 Head of *Ateles marginatus*.

Fig. 6 Head of *Cebus vellerosus*.

we have additional evidence of the action of sexual selection th gre t iz and trength of th males, and in the gre t r de lopm nt of their canin teeth n comparison w th th females.

A f w instances ll suffice of th trange mann n wl h both se es of some species are col red and of th be uty of oth rs. The face of th *Cercop thecus pet rus* (fig) is black, th whi kers and beard be g wh te, w th a d fined ro nd whit spot on the nose co red w th short whit hair wh h gi s to th animal an almost l d crous a pect The *Sem opithecus fro tatus* lik w se has blackish face w th a lo g black beard, and a la ge nak d pot on th f re h ad of a bluish whit col Th face f *Macacus lasiotus* is dirty fl h-col ured with a d fined red pot ach cheek. Th ppearance f *Cercocebus th ps* is grotesq e with its black face white whiskers and collar hestnut h ad and a large naked wh t spot o ach lid In ry many pe cies, th beard whisk rs, and cre ts f hair round th face re of a diff re t colou from the re t of th h ad and wh n d f ferent, are al y of a l ght tint.[a] be g lt n p re whit som tim bright y llow reddish Th wh l face of th So th Am rican *Brachyurus calvus* is of gl wing scarlet hu b t th is col does n t ppear til the animal is n arl ma ture.[b] Th naked kin f the face diff rs w nd rf ll n col ur in th ari u species. It is oft brown fl h-colour w th

Fig. 77 *Cercopithecus petaurista* (from Brehm).

[a] I observed this f ct in th Zoological C rd nd m y cases ma be see in th coloured plates in Geoffro St Hilaire and F C *Histo Nat. de M mm fères* tom. i., 1824

[b] B tes, *The Natu alist on the Amazons*, 1863, ol. ii., p. 310.

FIG 7 He d f *Semnopitl ec rubic d s* Th nd the f ll g figu es (from I r f ssor G rv is) re g n to h w the odd rr ge-m nt and dev lopm nt of th ha on the h d

tion made by Mr Sclater well illustrates our ignorance of the laws which regulate the appearance and disappearance of stripes the species of Asinus which inhabit the A iatic *continent are destitute of stripes,* not having even the cross shoulder stripe whilst tho e *which inhabit Africa* are conspicuously striped with the partial exception of *A tæniopus* which has only the cross shoulder stripe and generally some faint bars on the legs and this species inhabits the almost intermediate region of Upper Egypt and Abyssinia [4]

Quadrumana —Before we conclude it will be well to add a few remarks on the ornaments of monkeys In most of the pecies the sexes resemble each other in colour but in some as we have seen the males differ from the females e pecially in the colour of the naked parts of the skin in the development of the beard whiskers and mane Many pecies are coloure l either in so extraordinary or so beaut iful a manner and are furnished with such curious and elegant crests of hair that we can hardly avoid looking at these characters as having been gained for the sake of ornament. The accompanying figures (figs 7 to ι6) serve to shew the arrangement of the hair on

FIG 8 He d f S m p tl *comatus*

FIG 74 He d of *C l cap c us*

to believe that the aboriginal horse was striped on the legs and spine and probably on the shoulders [43] Hence the d sappearance of the spots and stripes in our adult existing deer pigs and tapirs may be due to a change in the general colour of their coats but whether this

without the aid of selection an l it is incon cei able that they can be of use in any or

cause it is impossible to decide An observa

to both se es With many of the Q iadrumana,

[43] *The Variatio f A mal nd Plant nder Domestication*, 1868 v l. i pp 61-64.

[44] *P oc Zool Soc* 1862, p 164 See also Dr Hartmann *Ann. d. Landw* Dd l s. 222

rangeme t of the crests and tufts f hai n their heads, f rce th con cli n m m nd that these charact ha e been acq red through sexual selecti n exclusi ly as rna ments.

mmary.—Tl law f battle f tl pos- ses.io oftl f mal ppears t pre ailthro gh out th wh l gre t lass f mammals. Most re t ze

f. se ce

for lif b t certain u generall th m l be g cces.f l . con

the po rf l od ra m tted b tl mal during th breeding season the od rif rous glands ha in bee acq ired thro gl se l select Wl th th sam w can be

ill conseq tl h been tran.m tted t the sam sex. Vari us cre ts, tufts, and man tles f hair h h are th confi ed t th male are m re d loped in thi sex than in th f m le seem most ases t be m rel ornamental, th h th som t m serv as d f nce gainst ri al males. Th re n so t uspect th t th b an l h rns f ta s, and th le ant b rns f certain ant lopes, tho gh prope l serving as w pons of off nce d f ce ha been partl modified f rnam t

Wh th mal diff rs in colour from tl f mal h g rall xhib ts dark and m re tro l -co trasted tints. W d n t thus class meet w th tl pl nd d red bl ll w and gree tints, so comm n with mal b rd and many th animals. Th naked parts, h we er of ce tain Quadrumana nu t be cepted for uch parts, often oddly situated are brilliantl col ured n some peci s. Tl col urs f tl mal n th ase m y be l to si pl ari t w tl ut tl e aid of sel c ti n B t wl tl col urs are di sif ed n l tro gly pron ced wh they are n t de l ped u t l ar m t rity and wl en tl y are l t aft emasc lati n we can hardl l tl co l n th t tl y h bee ac q red through sex al select on f r th sake f rname t and ha been transm tted l u l r almost x l usi l to tl sa se Wl n both se ar colo red n tl sa man r and tl colo are con.p or curi l arrange l w th t be g f the l ast app re t se as protect n, and espec ll wl th ar assoc ted w th ari tl orn t l t pe l es, w are led b anal gy t h

p cu ar l d rsified colou s, w u co f l l r comm n to both se es, re gro se

t, w ll be f nd to l ld good l w ook back t tl ari case gi n in this and th last l pt

Th law f tl eq l transmis n of l r act rs to both se s, as far as col ur and otl r ornam nt are co cerned has pre led far m re ext n l w th mammals than w th l rd l t w po s, l as h rns and t ks,

males t n nu f ll ki ds, th w pon

ance whi h l as pre ailed Finall w th q ad ruped th co test b tween th d d l f th sam se h th peacef l bloody l as, w th th rare t cept s, been confined t th mal so th t th latt ha been mod fied thro gh se al selecti far m re com m nl than th f mal s, th f fi ht g w th each th f lluring th opposit sex.

parts perfectly white and often as black as that of the most sooty negro In the Brach yurus the scarlet tint is l ... that of ... l It is ... in any ... and in several species it is blue passing into violet or grey In all the species known to Mr Bartlett in which the adults of both sexes have strongly coloured faces the colours are dull or absent during early youth This likewise holds good with the mandrill and Rhesus in which the face and the posterior part of the body are brilliantly coloured in one sex alone In these latter cases we have reason to believe that the colours were acquired through sexual selection and we are naturally led to extend the same view to the foregoing species though both sexes when adult have their faces coloured in the same manner

Although many kinds of monkeys are far from beautiful according to our taste other species are universally admired for their elegant appearance and bright colours The *Semnopithecus nemæus* though peculiarly coloured is described as extremely pretty the orange tinted face is surrounded by long whiskers of glossy whiteness with a line of chestnut red over the eyebrows the fur on the back is of a delicate grey with a square patch on the loins the tail and the fore arms being of a pure white a gorget of chestnut surmounts the chest the thighs are black with the legs chestnut red I will mention only two other monkeys for their beauty and I have selected these as presenting slight sexual differences in colour which renders it in some degree probable that both sexes owe their elegant appearance to sexual selection In the moustache monkey (*Cercopithecus cephus*) the general colour of the fur is mottled greenish with the throat white in the male the end of the tail is chestnut but the face is the most ornamented part the skin being chiefly bluish grey shading into a blackish tint beneath the eyes with the upper lip of a delicate blue clothed on the lower edge with a thin black moustache the whiskers are orange coloured with the upper part black forming a band which extends backwards to the ears, the latter being clothed with whitish hairs. In the Zoological Society's Gardens I have often overheard visitors admiring the beauty of another monkey deservedly called *Cercopithecus*

FIG 78 *Cercopithecus diana* (from Brehm)

diana (fig 78) the general colour of the fur is grey the chest and inner surface of the fore legs are white a large triangular defined space on the hinder part of the back is rich chestnut in the male the inner sides of the thighs and the abdomen are delicate fawn-coloured and the top of the head is black the face and ears are intensely black contrasting finely with a white transverse crest over the eyebrows and a long white peaked beard of which the basal portion is black

In these and many other monkeys the beauty and singular arrangement of their colours and still more the diversified and elegant

T ha se n mo t f th ... m k ... tl Zool g cal Soc ty s G rd ... Th descr pt ... f the *S mnopithecu nemæ* is t k ... f m M W C M rt ... *l Hist y f M mmal* 1841 p 460 ... pp 47 ... 523

ter being fully d   loped within   y ar n the Soudan, but not until three y ars in Egypt. The eyes of the negro are   t first blu   and the hair chestnut-brown r th r than black be ng curled onl   t the   nds. Th   ch ldren of the Australians immediat ly aft r b rtl   are   l- lowish-brown, and becom   d k t lat   e Those of the Guaranys   f Paragua   are whitish- ellow b t the   acquire in tl e course d   f w weeks the y llowish brown tint of their parents. S milar observ tions ha   been made in othe   parts of Am rica.

Th   pecified th f reg ing diff rences be tween the mal and f male se in mankind be- cause th   are curiously lik   those of th Quadrumana. W th tl ese animals th f male s mature t an arli   than tl ma   t least this is certainl   th case in C bus a a a The males of most   pecies are larg   and strong than the f males, f wh ch fact th gorilla affords   w ll-know instance E n in so trifling   charact   as th   great   promi- nence of th superciliary rid   th males of certain monke s diff   from th f males, and agree in this respect w th mankind In th gorilla and certain th   monkeys, th cranium of the adult male present   t o gl marked sagittal crest, which is abse t in t   f male and Eck f und   t ace of   similar diff rence between th   tw   se es in th Australians. W th mo key wh   th re is any diff rence in the voice that of th   mal   is th   m re pow ful. W ha   seen that certain mal m nkeys ha   well-d   loped beard which is quit de- ficient,   much less d   loped   th f mal N instance is kn wn of the beard whiskers, moustache bein   large in th f male than in th male monke   b   n in th colou   of the

reddish. I have repe tedly observed this fact in En land b t two gentlemen h   e lately written t me sa i g th t th s f rm an   cep- tion to   tle en ac cou ls colour s des of th   pec liarity (o e of th m ha been accused of d   ing h s beard)   n l had been thus led to obser oth r m n and were co   t ced that tl   ceptio s w re v ry rare Dr Hooke   tt nded to thi l ttle point f   me in Russia, nd f   nd no excepti n to tl e rule In Calcutta, M   J Scott, of th Botani Gar d ns, was so kind as t   observ   th man races of m n to be seen tl re as well as in som other parts f I dia, iam l   two races f S kl m th Bhoteas, H ndoos, B rmese and Ch nese th m t of which aces ha e   ry l ttl hai   n the face and h   l w y f und that wh n tl ere was any diff re ce in ol u between th hair f the h ad and the beard tl   latte was   ariably li ht   N w with m nkeys, as has already been tated tl   beard freq   ntl diff rs strik ngly in colour from the hair of tl   h ad and in such cases t is alw   f a l ,l t   h e being oft n pure whit   som times   llo or redd h.

In regard t   th   g   ral   airi ess of the body tl   w m n in all   aces are less hairy than th m n and in som f w Quadru nana the und   side of th body f the f male   l ss hairy than that of th mal   u Lastly male m nke s, lik m n, re bold   and fi rcer than th f males. Th y l ad th troop, and wh n th re is dang   com t tl   fro t. W th   see how close is th parallel sm between the se u l diff rences of man and th   Q adrumana. W tl som f w pecies, l w   w th certain baboons, th   rang and th gorilla, th re   a consid rably great   diff rence betwe   th se es, as in the size of th canine teetl in the d   lopm t and colour f th hair and espe

cially of light t nt, being oft n

Pruner Bey   egro nf   ts as quoted by V t, Lectures on M n, E g tra slat., 1864 p. 1 9 f further facts   negro nf   s, as quoted from W n- terbottom nd Camper see La rence Lect   on Physiology &   1 22, p. 451 F   the nf   ts of the Guara s, see R gger   ethier &c   S see also Godron, De l'Espe   tom. u. 1859 p 253 For he Australians, W tz, Introd to A thropology E g. transat 1863, p. 99

Re gger   gethier &c 1830, s. 49

As   Macacus cynomolgus (Desmarest, M m malogie p. 65), nd   Hylobate   gus (Geoffroy St Hilaire and F C   w   Histoire Nat. de M mmi- feres, 1 24   m 1, p. 2)

Anthropological Review Oct., 1868, p. 353.

M Blyth   forms me that h   has nly see   ne instance of the beard, hiskers, &c., in   monk y becom g h t   th ld ag   as   so ommo ly the case   th us. Th s, ho ever occurred   aged Macacus cynomolgus k pt   co finement whose mou taches were   rema kably lo g nd human- like. Altog ther this ld mo key prese ted ludi- crous resemblance t   of the reigning monarchs of Europe after   hom he was uni ersally nick named. I certain races of ma th hair   the head hardly ever becomes grey thus M D Forbes has never as he nforms me seen   insta ce with the Aymaras and Quechuas of South America.

This is the case with th females of several spe- cies of Hylobates see Geoffroy St Hilaire and F C vier Hist. Nat. de M mm., tom.   See also,   n H lar Penny Cyclopedia, ol u., pp. 149, 150.

Part Three

Sexual Selection in Relation to Man

and Conclusion

CHAPTER XIX

SECONDARY SEXUAL CHARACTERS OF MAN

With mankind the differences between the sexes are greater than in most of the Quadrumana, but not so great as in some, for instance, the mandrill. Man on an average is considerably taller, heavier, and stronger than woman, with squarer shoulders and more plainly pronounced muscles. Owing to the relation which exists between muscular development and the projection of the brows, the superciliary ridge is generally more marked in man than in woman. His body, and especially his face, is more hairy, and his voice has a different and more powerful tone. In certain races the women are said to differ slightly in tint from the men. For instance, Schweinfurth, in speaking of a negress belonging to the Monbuttoos, who inhabit the interior of Africa a few degrees north of the equator, says: "Like all her race, she had a skin several shades lighter than her husband's, being something of the colour of half-roasted coffee."[2] As the women labour in the fields and are quite unclothed, it is not likely that they differ in colour from the men owing to less exposure to the weather. European women are perhaps the brighter coloured of the two sexes, as may be seen when both have been equally exposed.

Man is more courageous, pugnacious and energetic than woman, and has a more inventive genius. His brain is absolutely larger, but whether or not proportionately to his larger body has [illegible]

In woman [illegible]

base of the skull [illegible]

body rounder, in parts more prominent, and her pelvis is broader than in man;[1] but this latter character may perhaps be considered rather as a primary than a secondary sexual character. She comes to maturity at an earlier age than man.

As with animals of all classes, so with man, the distinctive characters of the male sex are not fully developed until he is nearly mature; and if emasculated they never appear. The beard, for instance, is a secondary sexual character, and male children are beardless, though [illegible] they have abundant hair on the [illegible]

[illegible]

The female, however, ultimately assumes certain distinctive characters, and in the formation of her skull is said to be intermediate between the child and the man. Again, as the [illegible] though distinct species [illegible]

[illegible] tained that race-differences can [illegible] in the infantile skull.[4] In regard to colour, the new-born negro child is reddish nut-brown, which soon becomes slaty-grey; the black col[illegible]

[1] Schaaffhausen, translated in 'Anthropological Review,' Oct. 1868, pp. 419, 420, 427.

[2] 'The Heart of Africa,' English translat. 1873, vol. i. p. 544.

[3] [illegible] by W[illegible] [illegible] Wall[illegible] pp. 3, 355 [illegible] L[illegible] [illegible] tra[illegible] p. 81.

[4] Schaaffhausen, 'Anthropolog. Review,' ibid. p. 429.

sstriking full d loped within year in the woman, b t not until three y ars in Egypt. The eyes of the negro are at first bl and th air chestn t-brown rath than black, be g curled on at the nds. The children of th Australians immediat l after birth are yellowish-brown, and become dark t a lat a Those of the Guaranys of Paraguay re whitish elow b t they acq ire in the course of few weeks the Lowish-brown tint of their parents. imilar observ tions ha been made in other parts of America.

I have specified the fore oing diff rences be tween the male and female sex in mankind, because they are curiously lik those of th Quadrumana. With these animals th f male mature t an arlie than the male at least this is certainl th case in C bus azarae The males of most pecies are larg and stronger than the f males, of which fact th gorilla a ords w ll-known instance E n in

agree in this respect with mankind In the gorilla and certain othe monkeys, the cranium of the adult male presents trongl marked sagittal crest, which is abs t in t f male and Ecke found trace f a similar difference be ween the t sexes in th A tralians. With monkeys wh n there is any difference in the voice that of the male is th more pow ful. W have see that certain male monkeys have well-d loped beard, which is quit deficient, or much less d loped in the f male N instance is known of the beard whiskers, or moustache being large in th f male than in the male monke Eve in th colour of th beard there is curious parallelism between man and the Quadrumana, f w th man when the beard differs in colo from th hair of th head, as is commonl t case t is, I bel e, almost alw of lighte ti t, being often reddish. I ha e repeatedly observed this fact in England b t two gentl men has lately writt n to m sa in th t they form an exception to ~ ! On of these g ntlemen accounts colou sides of his famil of this peculiarity (on of th m ha ing often been accused of d ing h s beard) and had been thu led to observe ther m n, and were con nced that tl xceptio s w re rs rare Dr Hook att nded to this l ttle point f me in Russia, and f nd no e ception to t e rule In Calcutta, M J Scott, of th Botanic Gardens, was so kind as to observe the man races of men be see th re as well as in som other parts of I ha, nam l two races of Sikl m, the Bhoteas, Hindoos, B rmese and Chinese most of which races ha e ery little hair on the face and h alw f und that when th re was any diff rence in colou between th hair of th head and the beard the latt was n ariably l ght N w with m naeys, as has already been tated, th beard frequentl diff rs strikingly in colour from the hair of t h ad and in such cases t is alw of a l ght hu bei g oft pure white som tim low or redd sh.

In regard to th g neral airiness of th bod the w men in all races are less hairy than th men and in som f w Quadrumana the und sid of th bod of the f male is less hairy than that of th male Lastly male monk s, like m n, are bold and fi rce than th f males. They lead th troop, and wh n th re is dan come to th front. W th s see how close is the parallelism between th se u l diff rences of man and th Quadrumana. W th som f w pecies, h w as w th certain baboons, th orang and the gorilla, there a consid rabl great diff rence between th sexes, as in the size of th canine teeth in th d lopme t and colour of t hair and expe

Pruner Bey on negro infants as quoted by V gt, Lectures on M n, Eng. tra slat., 1864 p. 1 9 f further facts on negro nfan s, as quoted from Winterbottom and Camper see La rence Lect on P ysiology, &c 1 .d, p. 451 For the nfants of the Guaranys, see Rengger äugethiere &c s. 3 See also Godron, De l'Es ce om n. 1859 p 253. For the Australians, W z, Introd ction to A thropology Eng. transat., 1863, p 99

Rengger äugethiere &c 1830, s. 49.

As in Macacus cynomolgus (Desmarest, M mmalogie p. 65), and in Hylobates agilis (Geoffroy St Hilaire and F Cuvier Histoire Nat. des M mmifères, t 11 tom. i., p. 2)

Anthropological Review Oct., 1868, p. 353.

ever as he nforms me seen an instance with the Aymaras and Quechuas of South America.

This is the case with the females of several species of Hylobates see Geoffroy St Hilaire and F Cuvier Hist. Nat. des M mm., tom. See also, H lar Penny Cyclopedia, vol ii., pp. 149, 150.

cially in the colour of the naked parts of the skin than in mankind

All the secondary sexual characters of man are highly variable even within the limits of the same race and they differ much in the several races These two rules hold good generally throughout the animal kingdom In the excellent observations made on board the *Novara*[11] the male Australians were found to exceed the females by only 65 millim in height whilst with the Javans the average excess was 218 millim so that in this latter race the difference in height between the sexes is more than thrice as great as with the Australians Numerous measurements were carefully made of the stature the circumference of the neck and chest the length of the back bone and of the arms in various races and nearly all these measurements shew that the males differ much more from one another than do the females This fact indicates that as far as these charac ters are ... ale which has ... several races ... ock

The development of the beard and the hairiness of the body differ remarkably in the men of distinct races and even in different tribes or families of the same race We Europeans see this amongst ourselves In the Island of St Kilda according to Martin[12] the men do not acquire beards until the age of thirty or upwards and even then the beards are very thin On the Europæo Asiatic continent beards prevail until we pass beyond India though with the natives of Ceylon they are often absent as was noticed in ancient times by Diodorus Eastward of India beards disappear as with the Siamese Malays Kalmucks Chinese and Japanese nevertheless the Ainos[13] who inhabit the northernmost islands of the Japan Archipelago are the hairiest men in the world With negroes the beard is scanty or wanting and they rarely have whiskers in both sexes the body is frequently almost destitute of fine down ... On the other hand the Papuans of the Malay Archipelago who are nearly as black as negroes possess well-developed beards[17] In the Pacific Ocean the inhabitants of the Fiji Archipelago have large bushy beards whilst those of the not distant archipelagoes of Tonga and Samoa are beardless but these men belong to distinct races In the Ellice group all the inhabitants belong to the same race yet on one island alone namely Nunemaya the men have splendid beards whilst on the other islands they have as a rule a dozen straggling hairs for a beard[18]

... tinent ... in almost all the tribes a few short hairs are apt to appear on the face especially in old age With the tribes of North America Catlin estimates that eighteen out of twenty men are completely destitute by nature of a beard but occasionally there may be seen a man who has neglected to pluck out th ...

... am informed by Mr D Forbes who particularly attended to this point that the Aymaras and Quechuas of the Cordillera are remarkably hairless yet in old age a few straggling hairs occasionally appear on the chin The men of these two tribes have very little hair on the various parts of the body where hair grows abundantly in Europeans and the women have none on the corresponding parts The hair on the head however attains an extraordinary length in both ...

... body the sexes of the American aborigines do not differ so much from each other as in most other races This fact is analogous with what occurs with some closely allied monkeys thus the sexes of the chimpanzee are not

[11] The results ... deduced by Dr Weisbach from the measurements made by Drs K Scherzer and Schwarz see *Reise der Novara Anthropolog Theil* 1867 s 216 231 234 236 239 269

[12] *Voyage to St Kilda* (3d edit 1753) p 37

[13] J B ... Tr ... 1859 p 107

... Quatrefages ... Aug 29 1868 p 630 Vogt, *Lectures* ... Eng trans p 12

On the beards of negroes ... Vogt, *Lect* ... p 127 Waitz *Introduct to Anthropology* Eng trans 1863 vol i p 96 It is remarkable that ... United States (...

... *Anthropological* ... 1869 p 569) ... Wallace ... 1869 p ... D J B ... *Anthropological Review* ... 18...

as different as those of the orang gorilla.[21]

In the previous chapters we ha e seen that with mammals, birds, fishes, insects, &c., many characters, which there is rs reason to believe were primaril gained through se ual selection b ne sex, ha been transf rred to the other. As th same form f tran missi n has apparentl pre ailed m ch with mankind t will sa e useless repetition if w d scuss th origin of charact rs peculiar t th mal sex together with certain th characters common to both sexes.

H orum mulier teterrima bell causa. tn same of the North Am rican Indians, th contest is reduced to system. That cellent observ H arne[22] sa — It has been th custom amon these people f th m n to wrestle for an woman t whom th re t tached and, of course th trongest part al carries ff th prize A w ak man unless he be ood hunt and w ll-belo ed is seldom permitted to keep wif that stronger man thinks worth his notice This custom prevails throu ho t all th tribes, and causes a great spirit of mulatio am th th, who are po all occas ns, from their hild hood, tryin th ir trength and kill in wrestling. With the Guanas of So th Am rica, Azara tates that th men rarely marry till t ent ars ld more as bef re that ag they cannot co que thei ri als.

Othe similar facts could be gi n but n d had no id nce n this h ad w might feel almost sure from th analogy f th high Quadrumana,[23] that th law of battl had pre ailed with man d rin th earl tages of his d lopme t Th occasional ppearance at the present da of canin teeth which project abo th th rs, with traces f diast ma or pe space f th reception of th ppo t canines, is in all probabilit case f re rs n to f rmer st t wh n th progen tors of man were pro ided w th these w apons, like so man xist g mal Quadrumana. It was remarked n a f rm hapt r that as man grad uall became rect, and continually used his hands and arms f fight ng w th sticks and tones, as w ll as f r th oth purposes of life h would h e used hi j w and teeth l ss and less. Th j ws, to etl w th th ir muscles, w ld tl n ha e been reduced through disuse as would tl e teetl thro gh the not well und r stoo les f correlat n and eco om of gro wh siz tw manand ated Th case is alm t parallel w th that of many ts, n which th cani e teeth l ha of th diff re ce be ween in th orang and gorilla tand in lose relation w th th d lopm t of the immense ani e teetl in th males, w ma inf r that the reduction of th j w and teeth in th arl male pro nitors of man must ha led to a most striking and fa ourabl change in his ppearance

Th re can be little doubt that the gre t r size and tre gth of man, in comparison w th woman t geth w th his broad r sh ulders, more d loped muscles, rugged o tlin of bod his gre t courag and p gnac ty are all d in ch f part to inh ritance from hi half human mal ancest rs. These characters w ld h w ha e been preserved o n th long ages f man sav w uld h nsured th l ing a m re nu m rou pro en than th less f red brethren. It is n t probabl th t th gre t tre gth of man was primaril acquired thro gh th inh rited ffects f his ha ing w ked hard than w man fo hi own subsistence and that of hi famil f th w m n in all barbarous has lo g ceased th ther hand th m n, as a g ral rul h to w k hard than th w m n f th j mt subsistence, and thus th ir greate trength will ha been kept up.

America see Azara, Voyages, &c. tom. ii., p. 94

[23] On the fighting of the male gorillas, see Dr. Savage in Boston Journal of Natural History, vol. v 1847 p. 423. On Presbytis entellus, see the Indian Field, 1859 p. 146.

Difference in the Mental Powers of the two Sexes.—With respect to differences of this nature between man and woman, it is probable that sexual selection has played a highly important part. I am aware that some writers doubt whether there is any such inherent difference; but this is at least probable from the analogy of the lower animals which present other secondary sexual characters. No one disputes that the bull differs in disposition from the cow, the wild boar from the sow, the stallion from the mare, and, as is well known to the keepers of menageries, the males of the larger apes from the females. *Woman seems to differ from man in mental disposition, chiefly in her greater tenderness and less selfishness; and this*

lers. Woman, owing to her maternal instincts, displays these qualities towards her infants in an eminent degree; therefore it is likely that she would often extend them towards her fellow-creatures. Man is the rival of other men; he delights in competition, and this leads to ambition which passes too easily into selfishness. These latter qualities seem to be his natural and unfortunate birthright. It is generally *admitted that with woman the powers of intuition, of rapid perception, and perhaps of imitation, are more strongly marked than in man; but some, at least, of these faculties are characteristic of the lower races, and therefore of a past and lower state of civilisation.*

The chief distinction in the intellectual powers of the two sexes is shewn by man's attaining to a higher eminence, in whatever he takes up, than can woman—whether requiring deep thought, reason, or imagination, or merely the use of the senses and hands. If two lists were made of the most eminent men and women in poetry, painting, sculpture, music (inclusive both of composition and performance), history, science, and philosophy, with half-a-dozen names under each subject, the two lists would not bear comparison. We may also infer, from the law of the deviation from averages, so well illustrated by Mr. Galton, in his work on *Hereditary Genius*, that if men are capable of a decided pre-eminence over women in many subjects, the average of mental power in man must be above that of woman.

Amongst the half-human progenitors of man, and amongst savages, there have been struggles between the males during many generations for the possession of the females. But mere bodily strength and size would do little for victory, unless associated with courage, perseverance, and determined energy. With social animals, the young males have to pass through many a contest before they win a female, and the older males have to retain their females by renewed battles. They have, also, in the case of mankind, to defend their females, as well as their young, from enemies of all kinds, and to hunt for their joint subsistence. But to avoid enemies or to attack them with success, to capture wild animals, and to fashion weapons, requires the aid of the higher *mental faculties, namely, observation, reason, invention, or imagination.* These various faculties will thus have been continually put to the test and selected during manhood; they will moreover have been strengthened by use during this same period of life. Consequently in accordance with the principle often alluded to, we might expect that they would at least tend to be transmitted chiefly to the male offspring at the corresponding period of manhood.

Now, when two men are put into competition, or a man with a woman, both possessed of every mental quality in equal perfection, save that one has higher energy, perseverance, and courage, the latter will generally become *more eminent in every pursuit, and will gain the ascendancy.*[24] He may be said to possess genius—for genius has been declared by a great authority to be patience; and patience, in this sense, means unflinching, undaunted perseverance. But this view of genius is perhaps deficient; for without the higher powers of the imagination and reason, no eminent success can be gained in many subjects. These latter faculties, as well as the former, will have been developed in man, partly through sexual selection,—that is, through the contest of rival males, and partly through natural selection,—that is, from success in the general struggle for life; and as in both cases the struggle will have been during maturity, the characters gained will have been transmitted more fully to the male than to the female offspring. It accords in a striking manner with this view of the modification and re-inforcement of many of our mental faculties by sexual selection, that, firstly, they notoriously undergo a considerable change at puberty,[25] and, secondly, that eu

[24] J. Stuart Mill remarks (*The Subjection of Women,* 1869, p. 122), "The things in which man most excels woman are those which require most plodding, and long hammering at single thoughts." What is this but energy and perseverance?

[25] Maudsley, *Mind and Body*, p. 31.

racts remain throughout lif anf rs r m tl ese s e qualit es. Thus, man has ult mat l be- come superior to w man. It is, indeed f rtu nate that the law of th equal transmission of characters to both se es pre ails w th mam mas otherwise t is probabl that man w uld have become as superi in mental end wm nt to woman, as th peacock is in rnam ntal plumage to th pe h n.

It must be born in mind that th t nd ncy in charact rs acq ured b th r sex lat in Le, to be transmitted t the same sex at the same age and of rly acquired haract rs to be transmitted t both se es, are rules which, tough general, d not alw hold If th al- ws uld good, we might conclud (b t I h re exceed m proper bound) that th inherited effects of the arly ed cati n f bo and gi ls ould be transmitted equall t both sex so that th prese t inequal ty in mental pow be- tween the sexe w ld not be ffaced by a sim- ilar course of early training n t ha bee caused b ther dissimilar arl training. I ord that w man should reach th sam standard as man, she ght, wh n nearl adult to be trained t rgy and perse rance and to ha he reaso and imaginatio x rcised to the highest point and then sh would prob- abl transmit th se qualities chi fly t her adult daught rs. All w m n how could not be thus raised unless d rin many g n ations those wh celled n th abo robust virtues w re married and prod ced off prin in lar numbers than other w men. As be- fore remarked of bodil trength, alth gh men d t now fight for th ir w es, and thus form of selecti n has passed w t during manhood, th g n rall und rg a se re truggle in ord t maintai th mselv and their families and this w ll t nd t keep up increase th ir m ntal powers, and as conseq nce the present inequal ty between the se es.[32]

Voice nd Musical P wers —In som species of Quadrumana th re is a gre t diff rence be t een the ad lt se es, in th pow of th ir voice and in the development of th vocal organs and ff cord man th for t "arrests that promin nt g thyro d &c. which accompanies th elong ti n f tl e cords. [33] W th re pect to th cause of th difference between tl e sexes, I ha e nothing to add to the remarks n tl e last chap- t on th probabl ffects of tl lo g-contin ed use of th ocal organ b the mal und r th cit ment of lo e rag and j al u y Ac cording t Sr Duncan G bb [34] tl vo ce and th f rm of th larynx diff in the d ff rent races of mankind but w th th Tartars, Cl nese &c the oice f tl e mal s said n t to diff so much from that of th female as m most tl aces.

Th capacity and lo for nging or music th gh not a sexual haracter in man, must not h re be passed o e Although th sounds n tted by animal f all kinds serve man purposes, trong case can be mad out, that th ocal rgans were primaril used and per fected in relation t the propagati n f the pecies. Insects and som f w p d rs are the l west animal whi l v l ntarily produce an sound and tl is is g rall ffected by th aid of w f ll constru ted trid lating organs, w T s c l

Th sou d produced by nan al som cases t be mad nly b tl mal dur ng th breeding season. All the air-breathing V rt brata, necessaril posse s an pparat s f inhalin and xpelling ai with a pipe cap- abl of being closed t n nd Hence wh n th prim al membe of this lass were trong ly excited and th ir muscl lentl contract ed p rposeless sound w uld almost ce tainl ha been prod ced and these if th pro ed in an w service bl might readily ha been modified o int nsified by th preserva tion of prope ly ad pted ari tio s. Th low

[32] observatio b V gt bears this subject he says. It is remarkable circumst ce that th difference bet ee th se es, as regards the cra ial ca ty increases th the developme t of the race so tha the male European cels m h more the fe- male than th gro the gress. W lcker confirms this atme t of Huschk from his measurem ts of negro nd Germ kulis. B t V gt adm t Lect on M n, E g translat. 1864 p. 81) that more observati ns are requisit this poi t.

[33] Ow n, Anatomy f V ertebr te ol iii, p. 603

[34] J rnal of the Anthropological Society April 1869 pp l nd lvvi.

[35] D Scudder Notes Stridulation, in Pro Boston Soc. f Nat. H st., ol. xi., April, 1868.

... are incessantly used during the breeding season and which are often more highly developed in the male than in the female The male alone of ... utters a ... of love ... e same ... every one knows how much birds use their vocal organs as a means of courtship and some species likewise perform what may be called instrumental music

In the class of mammals with which we are here more particularly concerned the males of almost all the species use their voices during the breeding season much more than at any other time and some are absolutely mute excepting at this season With other species both sexes or only the females use their voices as a love-call Considering these facts and that the vocal organs of some quadrupeds are much more largely developed in the male than in the female either permanently or temporarily during the breeding season and considering that in most of the lower classes the sounds produced by the males serve not only to call but to excite or allure the female it is a surprising fact that we have not as yet any good evidence that these organs are used by male mammals to charm the females The American *Mycetes caraya* perhaps forms an exception as does the *Hylobates agilis* an ape allied to man This gibbon has an extremely loud but musical voice Mr Waterhouse states[30] It appeared to me that in ascending and descending the scale the intervals were always exactly half tones and I am sure that the highest note was the exact octave to the lowest The quality of the notes is very musical and I do not doubt that a good violinist would be able to give a correct idea of the gibbon s composition excepting as regards its loudness Mr Waterhouse then gives the notes Professor Owen who is a musician confirms the foregoing statement and remarks though erroneously that this gibbon alone of brute mammals may be said to sing It app ... d ... e ... from the analogy of other animals it is probable that it uses its musical powers more especially during the season of courtship

This gibbon is not the only species in the genus which sings for my son Francis Darwin attentively listened in the Zoological Gardens to *H leuciscus* whilst singing a cadence of three notes in true musical intervals and with a clear musical tone It is a more surprising fact that certain rodents utter musical sounds Singing mice have often been mentioned and exhibited but imposture has commonly been suspected We have however at last a clear account by a well known observer the Rev S Lockwood[3] of the musical powers of an American species the *Hesperomys cognatus* belonging to a genus distinct from that of the English mouse This little animal was kept in confinement and the performance was repeatedly heard In one of the two chief songs the last bar would frequently be prolonged to two or three and she would sometimes change from C sharp and D to C natural and D then warble on these two notes awhile and wind up with a quick chirp on C sharp and D The distinctness between the semitones was very marked and easily app ...

... for time yet she would keep to the key of B (two flats) and strictly in a major key ... Her soft clear voice falls an octave with all the precision possible then at the wind up it rises again into a very quick trill on C sharp and D

A critic has asked how ...

... musical note ...

... aerial simple vibrations of various periods each of which ... tly ... ed ... vi ... us ...

... e high importance of this power to all animals is admitted by every one—must be sensitive to musical notes We have evidence of this capacity even low down in the animal scale thus crustaceans are provided with auditory hairs of different lengths which have been seen to vibrate when the proper musical notes are struck[3] As stated in a previous

... duction ... p 432

[3] Am Nat ... 1871 p 761

[30] Helmholtz Théorie Phys de la M ... q ... 1868 ... 187

chapte sim lar bse ati n h b en mad
o the hairs f th ant mae f gn ts It l as l
l h ood b rve a l

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known to th an ts, and is oft n t k n d
antage f by the hunt s t th present
d

Th ref as f as the n percept n f
m ical t co cerned the eems no pe
cul diffi lty th ase f m n f n tl e
animal H lmh lt l as pl ed n ph o-
l gical prin pl by cord g e bl
and discord d sagree ble t tl l m
b t e are l ttl co ce ed w th these as m
sic in harm y l t m ent n W m e
concerned w th m lody a d l gain ac
cord g to H lmh lt t t ll gibl wh the
t f m cal scal re ed Tl

ant, and th tl wh l re l ss m ked re
th octa tl tw lfth tl seco d oct &c
all harm ni f tl f d m t l p d m l
t any t t f scal l m v f
t

comm —tl t s, h w ld hoo f mu
so g t whi h b l g t m cal scal
B t if t be furth asked wh m l to es
t cert d an l l thm g man and
th animal pl as re w an m g e
ll aso than f tl pl asant ss f cert
tast and ll Th t th d gr pl as re
f som k nd t m ls, m f f
th ir be g prod ced d g th aso f

ll ts l tl m l and tl compl tru t re
ft posse sed b tl m l w ld b se
less and th t mpos bl t b l

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ffect M l ach rtes t m that ld d g f his
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M R. B n, P oc Zool. Soc 1868, p 410

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n l g as w th us, n tl ma j r key b t
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ge

taught to do so thus a house parrow has learnt the song of a linnet As these two pe cies are closely allied and belong to the order of Insessores which includes nearly all the singing birds in the world it is possible that a progenitor of the sparrow may have been a so t I ots

ses

ocal

o gans can be taught not only to peak but to pipe or whistle tunes invented by man so that they must have some musical capacity Nevertheless it would be very rash to as ume that parrots are descende l f om

u for one purpose having been utilised for some distinct purpose [6] Hence the capacity for high musical development which the sav age races of man possess may be due either to the practice by our semi human progenitors of some rude form of music or simply to their having acquired the proper vocal organs for a different purpose But in this latter case we must assume as in the above instance of par rots and as seems to occur with many anim l that they already possessed some sense of melody

Music arouses in us various emotions but not the more terrible ones of horror fear rage &c It awakens the gentler feelings of tender ness and love which readily pass into devo tion In the Chinese annals it is said Music hath the power of making heaven descend upon earth It likewise stirs up in us the sense of triumph and the glorious ardour for war These powerful and mingled feelings may well give rise to the sense of sublimity We can concentrate as Dr Seemann observes greater intensity of feeling in a single musical note than in pages of writing It is pr bable that nearly the same emotions but much weak er and far less complex are felt by birds when the male pours forth his full volume of song in rivalry with otl e males to captivate the fe male Love is still the commonest theme of our songs As Herbert Spencer remarks music arouses dormant sentiments of which we had not conceived the possibility an l lo not know the meaning or as Richter says tells us of things we have not seen and shall not see Conversely when vivid emotions are felt and expre sed by the orator or even in common speech musical ca lences and rhythm are in stinctively used The negro in Africa when ex cited often bursts forth in son another will reply in song whilst the company as if touch ed by a musical wave murmur a chorus in per fect unison [37] Even monkeys express strong feelings in different tones—anger and impa tience by low —fear and pain l y high notes.[38] The ensations and ideas thus excited in us by music or expressed by the cadences of ora tory appear from their vaguene yet depth like mental reversions to the emotions and thoughts of a long past age

All these facts with re pect to music and im pas ioned peech become intelligible to a cer tain extent if we may assume that musical tones and rhythm were used by our half hu man ancestors during the season of courtship when animals of all kin ls are excited not only by love but by the strong pas ions of jealou y rivalry and triumph From the deeply laid principle of inherited associations musical tones in this ca e would be likely to call up vaguely and in lefinitely the strong emotions of a long past age As we have every rea on to suppose that articulate peech is one of the latest as it certainly is the highest of the arts ac juired by man an l as the instinctive po er of producing musical notes and rhythms is de veloped low down in the animal eries it w uld be altogetl er opposed to the principle of evolution if we were to admit that man s mu ical capacity has been developed from the tones used in impassioned speech We must sup pose tl at the rhythms an l cadences of oratory are derive l f om previously developed musical powers [3] We can thus understand how it is

[36] S e th cl pte p t d I l c a v l bl t l f \ th d mi b l F l f M l M l

J M 18 2 L p 313 [49] tl e O

vantage as ell l m t g l s d t g et l po bl wh ch th p r cpl f ut l ty m y n th con prehended in ts t \ l l e tt pted to sh w n ne rly h pt f tl k th p pl has an imp rta t b r ng tl q st n by m n f some of h n t l ch ct rist cs.

f y tt l e u d t l peech ff rd th l d t n f l mus has bee d l p d hl t l co l d tl t m l l d hythm first q d by tl m l f m l p g nt rs of m k d f tl k f ch rm g the

that music, dancing, so g and poetry are such very ancient arts. We may g en furth r than this, and as remarked in a former ch p- te beli that mus cal sou d aff rded ne of th bases f r tl e d l pm nt f lang ag
As the m l f sev ral quadruman u ani mals l e tl ocal gan m l m e d loped tl an tl e f mal s, and as a g l b n, of th anth pom rph apes, pou s f tl wh le oct f m cal not and m y b said t it ppears probabl th t tl pro- genitors f m n th th mal s f m l or both se es, bef re acq ir g th pow r of pressi g th m tual l n articul te lan gu ge, dea red t charm ach the w th m cal t and h thm So l ttl s kn wn abo t th se f the ce by the Q adrumana during th season f l tl at w b no m ans f j dgi g wh the th hab t f n g as first acquired by m l f mal an pe n W m g n rally th ght t pos-

ttract th th se B t if so tl mu ha occurred l g ag b f re u ance t rs had becom ffici tl h man t tre t and al th ir w m n m rel as sef l l Tl mpassio ed t bard m ci wh n th h aned t and cad nce b t th tro g t m t ns n b b rs, httl u pects th t h use tl sam m ns by wl h his half h m ance t rs l ng aroused ach th ard t pass ns, d ri g th ir courtsh p and ri lry

The I fluenc f B a ty determ g the M ag f M nk d—I ci lised l f man is larg l b t b n m ans l ly fl

enced the cl o ce of his wif by external ap- pearance but w are ch efly concerned with prime l t m s, and r only means of form ng a j dgm nt n th bject i t tu ly the l ab- ts of existi g semi-ci il sed and sa ge na ti ns. If it can be shewn tl t the men f d ff r nt races p f r w men h ng ari u har act ri tics, o con r ly w th the women, we ha th n t nq wl th r ucl cl o ce con t nued d ri g many gen r t o is, w uld produce any en bl ffect on the race e tl r ne sex or b th accord g to th form of inheritance wh ch has pre ailed

It will b w ll first to shew in some d ta l th t sa ag s p y th gre te t ttent nt th ir perso al ppearan e That th y l a a pas- n f ornam nt i ot ri s and an Engl sl phil so s so far as to maintain th loth f w h w a pl a- gance dec f l tature gaid by th l bou f a f tnigl t to procure n cl ng th *hica* necessary to pai t himself red Th anc ent barbarian f E rope dur ng the R ndee period bro ght to the s brill ant s gular bjects wl i h th y h ppe ed to find S g t tl p esent d v e wh deck th msel s with pl mes, neckl th m If l as l thed n t ns, t w ld l e been pe cei ed th t th most f rt l imagi t n d them t mutabl caprice h ted th fash f painti g as w ll as th se f garm nts

ppos t se Thus mus cal t es becam firmly as- sociated th som of th tro gest passi ns nimal capable of feel g d ar co seq tly used n t cti l thro gh assoc tio wh stro g m are p essed speech M pen- cer does ot ff y satisf ct ry planati ca l, hy h gh deep tes should be xpress both th m d th l imals, f certa moti ns. M pe cer g es lso t rest g dis- cuss th rela ns bet poetry ec t li nd so g

I fi d Lord M bodd *Orig f La gu g* l l 4 p 4 9 th t D Bla klock l k ise tho ght th t th first la guag mo g m w mus d th t bef re ur d as re pressed by art cul t so nds, th y re commun cated by t es varied accord g t diff re t d grees of gra ty d cut esa.

See t resti g discuss this bject by Haeckel, *Gener lle Morphologie* B n., 1866, s. 246

Humboldt, *Per onal* t E g translat. l p 51 th m gi sh w p ti g th body p 522 modify g th f m of th calf of th l g p 466

taught to do so thus a house parrow has learnt the song of a linnet As these two species are closely allied and belong to the order of Insessores which includes nearly all the singing birds in the world it is possible that a progenitor of the sparrow may have been a songster It is more remarkable that parrots belonging to a group distinct from the Insessores and having differently constructed vocal organs can be taught not only to speak but to pipe or whistle tunes invented by man so that they must have some musical capacity Nevertheless it would be very rash to assume that parrots are descended from some ancient form which was a songster Many cases could be advanced of organs and instincts originally adapted for one purpose having been utilised for some distinct purpose [36] Hence the capacity for hi h musical development which the savage races of man possess may be due either to the practice by our semi human progenitors of some rude form of music or simply to their having acquired the proper vocal organs for a different purpose But in this latter case we must assume as in the above instance of parrots and as seems to occur with many animals that they already possessed some sense of melody

Music arouses in us various emotions but not the more terrible ones of horror fear rage &c It awakens the gentler feelings of tenderness and love which readily pass into devotion In the Chinese annals it is said Music hath the power of making heaven descend upon earth It likewise stirs up in us the sense of triumph and the glorious ardour for war These powerful ... ngs may ... We can ... greater ... ty of feeling in a single musical note than in pages of writing It is probable that nearly the same emotions but much weaker and far less complex are felt by birds when the male pours forth his full volume of song in rivalry with other males to captivate the female Love is still the commonest theme of our songs As Herbert Sp... or as Richter says tells us of things we have not seen and shall not see. Conversely when vivid emotions are felt and expressed by the orator or even in common speech musical cadences and rhythm are instinctively used The negro in Africa when excited often bursts forth in son... another will reply in song whilst the company as if touched by a musical wave murmur a chorus in perfect uni on [3] Even monkeys express strong feelings in different tones—anger and impatience by low —fear and pain by high notes [3] The sensations and ideas thus excited in us by music or expressed by the cadences of oratory appear from their vagueness yet depth like mental reversions to the em tions and thoughts of a long past a e

All these facts with respect to music and impassioned speech become intelligible to a certain extent if we may assume that musical tones and rhythm wer ...

... by the strong passions of jealousy rivalry and triumph From the deeply laid principle of inherited associations musical tones in this case would be likely to call up vaguely and indefinitely the strong emotions of a long past age As we have every reason to suppose that articulate speech is one of the latest as it certainly is the highest of the arts acquired by man and as the instinctive power of producing musical notes and rhythms is developed low down in the animal series it would be altogether opposed to the principle of evolution if we wer to ...

... rhythms and cadences of oratory are derived from previously developed musical powers We can thus understand how it ...

[36] Sin ... th ... valuabl ... rt ... by Mr Ch ... cey W ... ght (N ... th Am ... n R ... w O ... t 18 ... ds- ... Th ...

... t h. ... tt pted ... to h ... in an e rly ch pt ... f tl ... th ... c ple h ... n mp rta t b ... go tl ... equ ... by ... man f s m of h s n nt l ch ... t ist cs.

... ll h mus c has bee ... d ... l ped ... h lst l co cl d tl t mus al ... tes d ... hyth ... fi t ... eq ... ed by th m l ... r f male p og n t rs f m ... k d f ... tl ... sak f ch rm ng th

unnaturally modified has escaped The amo nt of uff ring thus ca sed must ha b n x trem f r many f th operati ns r qu re eral y ars f the compl ti n so th t tl e d a d th ir ecessity m t b mperat Th mo ti es are ari th m p int tl e bod es to mak th msel i pea t rribl n battl ce tain m t l t re nnected w tl l gious t s, tl y m k tl ag f pub rty th ank f th m or tl v serv t d s- tinguish the t b lm g t sa ag s tl sam f l g periods,[9] and tl d

tion of th rs, seem t b n ous ti es. I regard t tattoo g I was t ld b the mis N w Ze land that wl n they tried to pers ad so g ls t g up tl practice tl y ns ed W m t ju t h f w h n our l p lse wl g w ld e hall be so y gly W th th m n f N w Ze la d m t p bl judg says, to h fi tattooed face w tl g t m b tw f th y g b tb to d th msel s ttr cti t th lad s, and con p u n war A t tattooed th f l ad and a spot th chi tl ght b th w m n n h t t l tt ac t l

th gh artly th w m n re ru rnamented A tl m n ar mad by ages to perf m th gre t t bare f th w k, and as th y are n t ll ed to t tl b t k rro l w th th haract

]

rnam ti g th has p ng m w l m

tin t nati ns, sh uld be d e to trad tion from any comm n source They ind cate tl e lose sim larity f th mind of man to wl at er race l e may b long ju t as d tl e almost u rsal h b ts of dan ng, masquerad g and m ki g de p ctures

Ha ng made th se pr l n n v rem ks on tl adm t n felt by sa ages for arious orna m nt d f r d f rm ties m t un ghtly in our s, l t u se l ow far tl m n are att act ed b th app ar nce f the r women nd wl t are tl d as f b ty I h b ard it main t ed tl t ag re qu l nd ffer nt ab ut the b a ty f tl r wom n lu ng tl em solely as l es t may tl f b well to observe th t tl is co lu n does n t t all g ee with th are wl h the ncn take in rnam nting th msel s, w th tl r nts Bu l ll[8] g n am ng account f a bu l w man wh u ed as m l gr ase ed ochre and h n ng powd as w uld ha ed an but a ry n h hu b d Sh d played lso mu h nity and too d nt consei u n s of her upe nty M W nwood R ade i forms me that tl e n groes of tl w t ast ft n d s- cuss the be uty f tl w m n Som compe- t nt bser rs l a e ttrib ted tl e f arfully comm n p act ce f infant de partly to the d t h tl w m n t tain the r good l

f pl nts ed f th pu pose f n th w t n Am n a.[56]

H arn [34] an ll nt bse r wh h ed m y w th th Am can I d ans says, n peaki g f th w m n A L rth rn Ind n wh t b a ty and l w ll answ a b ad fl t fac mall y s, l gh heek b n s, three f u broad black l as ach h k, l w f h ad a l g b d hin, a l m y hook n se ta ny h d and b easts h g ng d wn t th b lt P llas, wh ted tl th n parts f the Chi se mp says, l the

[?] B ker (bid l p 210) pe k g f th t f ce tral Af ca say E ry tr be has d l ct d bang g f h f dress g th hai See Agassiz (J rney B zil 1868 p 318) ariability of th tattoo g of Amazo ia Ind ns.

Re R. T yl New Z al nd nd its Inhabitants 1855 p 152

M t gazza, l gg Stud p. 542.

[?]T ls tl th Afric 1824 l. i., p 414 [?]See, f ref ces, G ls d Über das Ausster ben der Nat rvolker 1868 ss. 51 3 55 als Azara, I y g d t m p 116

[?]O th g tabl prod cts used by th rth west Am rica I dians, see Pharmac utical J nal, l.

A J rney f om Princ f W ale F t, 8 o. ed 1 96 p 89

In one part of Africa the eyelids are coloured black in another the nails are coloured yellow or purple In many places the hair is dyed of various tints In different countries the teeth are stained black red blue &c and in the Malay Archipelago it is thought shameful to have white teeth like those of a dog Not one great country can be named from the polar regions in the north to New Zealand in the south in which the aborigines do not tattoo themselves This practice was followed by the Jews of old and by the ancient Britons In Africa some of the natives tattoo themselves but it is a much more common practice to raise protuberances by rubbing salt into incisions made in various parts of the body and these are considered by the inhabitants of Kordofan and Darfur to be great personal attractions In the Arab countries no beauty can be perfect until the cheeks or temples have been gashed [44] In South America as Humboldt remarks a mother would be accused of culpable indifference towards her children if she did not employ artificial means to shape the calf of the leg after the fashion of the country In the Old and New Worlds the shape of the skull was formerly modified during infancy in the most extraordinary manner as is still the case in many places and such deformities are considered ornamental For instance the savages of Colombia deem a much flattened head an essential point of beauty

The hair is treated with especial care in various countries it is allowed to grow to full length so as to reach to the ground or is combed into a compact frizzled mop which is the Papuan s pride and glory [46] In northern Africa a man requires a period of from eight to ten years to perfect his coiffure With other nations the head is shaved and in parts of South America and Africa even the eyebrows and eyelashes are eradicated The natives of the Upper Nile knock out the four front teeth saying that they do not wish to resemble brutes Further south the Bakotas knock out only the two upper incisors which as Livingstone[47] remarks gives the face a hideous appearance owing to the prominence of the lower jaw but these people think the presence of the incisors most unsightly and on beholding some Europeans cried out Look at the great teeth! The chief Sebituani tried in vain to alter this fashion In various parts of Africa and in the Malay Archipelago the natives file the incisors into points like those of a saw or pierce them with holes into which they insert studs

As the face with us is chiefly admired for its beauty so with savages it is the chief seat of mutilation In all quarters of the world the septum and more rarely the wings of the nose are pierced rings sticks feathers and other ornaments being inserted into the holes The ears are everywhere pierced and similarly ornamented and with the Botocudos and Lenguas of South America the hole is gradually so much enlarged that the lower edge touches the shoulder In North and South America and in Africa either the upper or lower lip is pierced
" !

a curious account of the shame felt by a South American native and of the ridicule which he
ey ! !

iate the lower lip and wear a crystal which from the movement of the tongue has a wriggling motion indesc ibably ludicrous during conversation The wife of the chief of Latooka told Sir S Baker[48] that Lady Baker would be much improve l if she would extract her four front teeth from the lower jaw and wear the long pointed poli l ed crystal in her under lip Further south vitl the Maka
! !

project two inches beyond the tip of the nose and when the lady smiled the contraction of the muscles elevated it over l er eyes Why do the women wear these things the venerable chief Chinsu di was asked Evidently surprised at such a stupid que tion he replied For beauty! They are the only beautiful things women have men have beards women have none What kind of a pe son would she be without the pelelé She would not be a woman at all with a mouth like a man but no beard [9]

Hardly any part of the body which can be

[44] Th N le Trib tari s 1867 Tl ill t V

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Tr vels p 533

Th Alb t N y n a 1866 v l i p 217

L ing t n Brit h A ociation, 1860 r port gi en in the Athenæ m July 7 1860 p 29

according to Madam Pf iff r a be uty A m.n of Cochin China poke with contempt f the wif of th English Amba.sad r th t she had but teeth like a d g and a rosy col ur lik that of potato-fl s. W ha seen that the Chi ese dislik ur wh t k n, and th t the N Americans admire a t wny hide In S. America, the Yuracaras, wh inl b t tle h t m Cord l

le

n

theless they

inferio to th ir wn.[18]

In se eral of th tribes f N th Am rica the l h h ad grow to a w nd rf l l ngth

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hair of any man in th tribe nam y and se in hes. The A maras and Queel as of S. Am rica, lik wise ha e ry l ng l air and thus, as Mr D F bes inf rms m is so much al ed as be t th t tting t off was the sev rest punishm t wh h h could inflict them. I both th n th rn and southern hal f th co ti t tl nat es sometimes increase th ppare t l ngth of their hair by w g nt t fibrous ub tan ces. Altho gh th hair n th h ad is th ch rished, that n th face con d red by th N rth American Indian as ry vulgar and ry hai s arefull rad cated Th s practice pre ails thro gh t th Am rican continent from Vancou I land th north t T rra d l F g n th so th Wh n Y k Minst F gian n board th *Bea* h h k t his country th na

t trip h m naked and pt k his

d t wish to be lik h rses.[20]

It is remarkabl that thro gh t th w M the races wh h are alm ost completely desti tute f a beard dislik hairs on the face and body and take pains to erad cat th m. The Kalmucks are beardl ss, and th y are well known l k the Am ricans, to pluck out all st aggl ng hairs and so it is with the Poly ne- ans, some f th Mala s, and th Siamese Mr V t l tate that the J pan e lad s all bjected to ur wh k rs, consideri g th m ry gly nd t ld us t cut th m off and be like Japanese m n Th New Zealand rs ha e sh rt, u led b ards y t th f rm r ly plucked ut th hairs n the face Th y had say ng that th re is no w man f r a hairy man but it w uld appear th at the fash n has hanged n N w Zealand perh ps ow g t the presence of E ropeans, and I am assured that beards are n w admired b the Maori s.[21]

O the oth r hand bearded races adm re and greatl alue th r b ards am ng th Anglo-Sa. had a recognise

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the East m

W ha seen th at Chinsurd the ch f of the Makalol n Africa, th ght th at beards re gre t rnament. In th Pacific the F j an s beard is prof se and bushy and s his gre t est prid whilst th inhab tants of the adjacent arch pelagoe of T nga and Samoa are beardl ss, and abh r a rough chin. In land f ne f th Ell ce gro p th m n are h l bearded and not a littl proud th reof [22]

W thus see h w wid ly th diff rent races of man diff in th tast fo th be utiful. In y nat n uffi atly ad anced t h mad ffigies of th gods f th r d ified rul rs, th sculptors no d bt ha nd a n ed to exp ss th high t ideal f be uty and grand ur.[23] Und r this point of w it i w ll to compare in mind th J p t Apollo of the Greeks w th th Egyptian or Assyrian t tues and th se with the hideous bas-relief n th ruined building of C ntral Am rica.

[18] For the J an nd Cochin-Chinese see Waitz, *Introduct to Anthropology* E g. translat. l i, p. 305 O th Yuracaras, A d Orbig y as q ted Prichard, *Physical History f Mankind* ol. 3rd ed p. 4 6

[19] *North America Ind ans* by G Catlin, 3rd ed., 1842, vol. p 49 l p 227 O th nat es of Vanco Isla d, see Sproat, *Scene nd tud of Savage Lif* 1868, p. 25 On the Indians of Paraguay Azara, *V y ges*, t m. ii., p. 105.

[20] O th Siamese Prichard, *ibid* vol. p 533. O th J pa ese V tch *Gardeners Chronicle* 1860 p. 1104 O th N w Zealand rs, M t gazza, *V ggi Studi*, 1867 p. 526. For th ther nations me t ed, see ref rences in La rence, *Lect on Physiology* &c., 1822, p. 272.

[21] Lubbock *Origi f Civilisation*, 1870 p. 321

[22] D B nard D is quot M Prichard and thers for these f cts in regard t th Polynesians, in *Anthropolog Rev w* April, 18 0 pp 185, 191

[23] Ch. Comt has remarks t this ffect in his *T it de Législation*, 3rd ed., 1837 p. 136.

mous ears.[57] and Vogt remarks that the obliquity of the eye, which is proper to the Chinese and Japanese, is exaggerated in their pictures for the purpose, as it "seems, of exhibiting its beauty, as contrasted with the eye of the red-haired barbarians." It is well known, as Huc repeatedly remarks, that the Chinese of the interior think Europeans hideous, with their white skins and prominent noses. The nose is far from being too prominent, according to our ideas, in the natives of Ceylon; yet "the Chinese in the seventh century, accustomed to the flat features of the Mongol races, were surprised at the prominent noses of the Cingalese; and Thsang described them as having 'the beak of a bird, with the body of a man.'"

Finlayson, after minutely describing the people of Cochin China, says that their rounded heads and faces are their chief characteristics; and, he adds, "the roundness of the whole countenance is more striking in the women, who are reckoned beautiful in proportion as they display this form of face." The Siamese have small noses with divergent nostrils, a wide mouth, rather thick lips, a remarkably large face, with very high and broad cheek bones. It is, therefore, not wonderful that "beauty, according to our notion, is a stranger to them. Yet they consider their own females to be much more beautiful than those of Europe."[58]

It is well known that with many Hottentot women the posterior part of the body projects in a wonderful manner; they are steatopygous; and Sir Andrew Smith is certain that this peculiarity is greatly admired by the men.[59] He once saw a woman who was considered a beauty, and she was so immensely developed behind, that when seated on level ground she could not rise, and had to push herself along until she came to a slope. Some of the women in various negro tribes have the same peculiarity; and, according to Burton, the Somal men "are said to choose their wives by ranging them in a line, and by picking her out who projects farthest *a tergo*. Nothing can be more hateful to a negro than the opposite form."[60]

With respect to colour, the negro ...

... considered as "unsightly and unnatural conformations." He in return praised the glossy jet of their skins and the lovely depression of their noses; this they said was "honeymouth," nevertheless they gave him food. The African Moors, also, "knitted their brows and seemed to shudder" at the whiteness of his skin. On the eastern coast, the negro boys when they saw Burton, cried out, "Look at the white man; does he not look like a white ape?" On the western coast, as Mr. Winwood Reade informs me, the negroes admire a very black skin more than one of a lighter tint. But their horror of whiteness may be attributed, according to this same traveller, partly to the belief held by most negroes that demons and spirits are white, and partly to their thinking it a sign of ill-health.

The Banyai of the more southern part of the continent are negroes, but "a great many of them are of a light coffee-and-milk colour, and, indeed, this colour is considered handsome throughout the whole country;" so that here we have a different standard of taste. With the Kaffirs, who differ much from negroes, "the skin, except among the tribes near Delagoa Bay, is not usually black, the prevailing colour being a mixture of black and red, the most common shade being chocolate. Dark complexions, as being most common, are naturally held in the highest esteem. To be told that he is light-coloured, or like a white man, would be deemed a very poor compliment by a Kaffir. I have heard of one unfortunate man who was so very fair that no girl would marry him." One of the titles of the Zulu king is "You who are black."[61] Mr. Galton, in speaking to me about the natives of S. Africa, remarked that their ideas of beauty seem very different from ours; for in one tribe two slim, slight, and pretty girls were not admired by the natives.

Turning to other quarters of the world; in Java, a yellow, not a white girl, is considered

57 Quoted by Prichard, *Phys. Hist. of Mankind*, 3rd edit. vol. iv. 1844, p. 519. Vogt, *Lectures on Man*, Eng. translat. p. 129. On the opinion of the Chinese on the Cingalese, E. Tennent, *Ceylon*, 1859, vol. ii. p. 107.

58 Prichard, as taken from Crawfurd and Finlayson ...

59 ... *quondam permagno aestimari ab hominibus in hac gente. Nunc res mutata est, et censent talem conformationem minime optandam esse.*

60 *The Anthropological Review*, November 1864, p. 237. For additional references, see Waitz, *Introduct. to Anthropology*, Eng. translat. 1863, vol. i. p. 105.

61 Mungo Park's *Travels in Africa*, 4to. 1816, pp. 53, 131. Burton's statement is quoted by Schaaffhausen, *Archiv für Anthropolog.* 1866, s. 163. On the Banyai, Livingstone, *Travels*, p. 64. On the Kaffirs, the Rev. J. Shooter, *The Kafirs of Natal and the Zulu Country*, 1857, p. 1.

actlvtl sam prin pl a d tl sai le t carry ery po t t a ext me w l l it also, th sam sp t f mulat n B t tl e f h ns of sa ag s re f m pe manent than ur and wh tl bod are art fi ally mod fied tl ece sarıl the case Tl Arab w m n f tl e Lppe N le occupy abo t three d s d ng tl l a th y m tate the t b l t mply e h th th upe l t ss f th r i f tl

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ha been k pt m rely f rnam t t b som wh t n

be so co t tuted tl t brill ant ta f rms, as w ll as l rm us d s cal so ds, gı pl a. d ar B tıf l b t nl th l ld b so w t It cert ly t t tl t tl re mind f ma m u sal tandard f y tl re pect t th h m body It

h wever p ss ble tl at certain ta t m y the ou f t m becom ı l ented tl igl f of tl s bel ef th and nat gu u

B tru ture f tl lo r d bt tl sı pa tly t ue tl tl n rece l sed n t n n wh l t llect l gl ly app eci ted b t th expla t n will l dly apply to all f rms f ughn ss Tl m n f acl ce p e fer wl t th y accu t ned t th y c nn t ndure any g t cl ng but tl ev lık arı ty nd dm re acl l act ı t carried to a mod t ext en M n accu t med to a n l l face t tr gl t ar d g l r f t re n l t l ngl t l u adm e as w European kn tl se po ts l en t ongly d l ped On tl tl r l an l m n accu t m ed t b d f ce w tl l l l eck b n s a l pre sed n se and a black h dm re tl se pec l t wh t ngly m ked No doubt h act rs f ll k d m y b too muc l d l ped f b uty H nce a p rfect b ty wh h mpl m ny l act rs mod fied m a p t ul man r w ll be n r ace a p od gy As tl gre t anat m t B cl at long g d if ery w ast n th sam m ld l th ng as b uty If ll as tl b l t w l g t dard

uthsonia Instit t 1863 p 259 O th f Arab w m S Bak The Nile t ne 1867 p 121 The Variat on f A mals nd Plants nd Do- ation, L p 214 l B 240

Sch ffhausen, Arch f Anthr pologı 1866 qui th sam

I have met with very few statements opposed to this conclusion Mr Winwood Reade however who has had ample opportunities for observation not only with the negroes of the west coast of Africa but with those of the interior who have never associated with Europeans is convinced that their ideas of beauty are *on the whole* the same as ours and Dr Rohlfs writes to me to the same effect with respect to Bornu and the countries inhabited by the Pullo tribes Mr Reade found that he agreed with the negroes in their estimation of the beauty of the native girls and that their appreciation of the beauty of European women corresponded with ours They admire long hair and use artificial means to make it appear abundant they admire also a beard though themselves very scantily provided Mr Reade feels doubtful what kind of n

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u however bear in mind that the depressed broad noses and projecting jaws of the negroes of the west coast are exceptional types with the inhabitants of Africa Notwithstanding the foregoing statements Mr Reade admits that negroes do not like the colour of our skin they look on blue eyes with aversion and they think our noses too long and our lips too thin He does not think it probable that negroes would ever prefer the most beautiful European woman on the mere grounds of physical admiration to a good looking negress [68]

The general truth of the principle long ago insisted on by Humboldt [9] that man admires and often tries to exaggerate whatever characters nature may have given him is shown in many ways The pra t f t

The skull has been greatly modified during ancient and modern times by many nations and there can be little doubt that this has been practised especially in N and S America, in order to exaggerate some natural and admired peculiarity Many American Indians are known to admire a head so extremely flattened as to appear to us idiotic. The natives on the north western coast compress the head into a pointed cone and it is their constant practice to gather the hair into a knot on the top of the head for the sake as Dr Wilson remarks of increasing the apparent elevation of the favourite conoid form The inhabitants of Arakhan admire a broad smooth forehead and in order to produce it they fasten a plate of lead on the heads of the new born children On the other hand a broad well rounded occiput is considered a great beauty by the natives of the Fiji Islands [0]

As with the skull so with the nose the ancient Huns during the age of Attila were accustomed to flatten the noses of their infants with bandage for the sake of exaggerating a natural conformation With the Tahitian to be called *long nose* is considered as an insult and they compress the noses and foreheads of their children for the sake of beauty The same holds with the Malays of Sumatra, the Hottentots, certain Negroes and the natives of Brazil [1] The Chinese have by nature unusually small feet and it is well known that the women of the upper classes distort their feet to make them still smaller Lastly Humboldt thinks that the American Indians prefer colouring their bodies with red pa t d

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may be doubted whether barbarous nations have generally had any such intention in painting themselves

In the fashions of our own dress we see ex

n Af n Sk t h R t

pp 253 med by c d r but f m

n t we na m f th j dgm nt f th th r b- or gines f Am r ca, I cann t b t th nk th t th must be a mist k u l ss d ed th t t ment r f rs to th few ku s who ha l d f r s me time with Europ an nd wh must on d us as super b ng I hould add th t m t pe- rienced obs C pt. Burt b l th t a wom n whom we con d r b a tif l is dmired throughout the w ld. *Anth opol g al Review* March 1864 p 245

[9] *Personal N rr t ve* Eng tr sl t v l v p 518 and el wh e. Ma teg z a, n his *V iagg e Studi*, strongly insists n this same principle.

[0] On th k lls f th Ame c n tr bes ee Nott d Cl dd *Type f M nkind* 1854 p 440 Pr ch rd *Phys al Histo y f M k nd* vol 3rd d p 321 on th at e f Ar kh n *ibid* v l p 537 W ls n *Phys al Eth nol gy* Sm ths ia I t tu ti 1863 p 288 n th F j ns, p 290 Sir J L b b k (*Preh tori T m* 2 d d 1869 p 06) gives t celle t résum this subj ct.

[1] On th Hu Godr n *D l'E pèce* t m 1859 p 300 On th T h ti ns Wa tz *Anth pol gy* E g translat. v l p 305 M rsd n qu ted by Pr ch ard *Phy Hist.* f *M nkind* 3rd ed t. v l p 67 La rence *Lect s o Physiology* p 337

[2] Th f t was asc rta ed n th *Reis der Nov Anth opolog Theil.* Dr W isbach 1867 s 265

famous as the most be tiful n tl land nd re sought by arti ts as mod ls. B t t is b- vious that th e d ce n all the abo e ases is doubtf l.

The f llo ing case th ugh relat g t sav ges, is ll w rth gi g f t curious! Mr Win ood R ade nf rm m th t the J ll fs, a t be of negroes n th w t coa t of Africa, are remarkabl f r th ir unif rml fi e p- pearance A friend f l a ked n of these men Il w is t th t e ry wl m I meet is so fin lookin, not only m but o omen Th J llof a w red It is very eas plained t has al s been r cu t m t pick t ou rst lookin g sl and t sell them. It need hardl be added th t tl all sa ages, f m l sla se as cc cub That thus wroab uldha tt l ted wl tl g tl wro gl th fi ppe rance I l true t th lo co ts ed I mun t n f tl l m n n t so rprise as t n t first ppear for I h lsewh re sh wn th t ne ree full pprec t tl po tan e f select th breed g f tl d m ti animals, and I co ld from M R de additional vid ce this t d

The C use wh h p ent heck the Act f Sexual S lect with S —Th h f ca ses are first so-call d co n l m rr ges or promiscu us t recourse second th consequ nce f f mal f t l tl rdl earl l t tl lowest m t n m f

man. f an tl an sal l lt t m re liance n th to l ce rted b th se there can be se u l selectio and ffect will be prod ce l tl ff pring h erta od d l. l g i d ad ar t g others tl cc t h p N w t asserted that th re a t t tl present d tribe wl h pract se wl t S J L l bock t co tes alls commu al marri tl t is, all tl m d w m th tribe re l sband d w t one an tl Th lwe t nes f wan sa are d l t a t l g b t t seems t m th t m re ad re req t bef re w f ll ad t that tl t vo rs is an any case j ro m se N rth l ss all thos who ha most losel t d ed th bject, and

whose judgment is worth much more than n n bel tl t commun l marriage (this expressi be g ar u ly guarded) was the orgin l and un ersal f rm throughout the w rld l d tl re n tl nt rmarri ge of broth rs and s t rs. The l te S r A Sm th who had tra lled wid ly n S Africa, and kn w much abo t tl e l b ts of sav g th re l lsewl re pressed to m tl e stro gest p n tl t no race t n wh ch om n is co d red as the p rope t of tl e co m n t I b l that l is j dgme t was larg ly l t rmi ed l what i impl ed by tl e t n mar riag Throughout th f llow g d scus n I use tl term in tl sam nse as wl e n tu alist peak of an mal as mono mous, m an ng tl reb that tl e male i accepted by r l ose gle f m l and l e with l r tl l ri th breed g seaso r for tl wl l year keep g possessio f l b th law of m gl t as wl n tl y pe k of a pol ga is pec es, m an g tl t tl mal l es w tl se l f n l s. Thus k d f nar all tl t concern u l re as t ufl ces f tl k f sexu l select n B t I kn w tl t so f tl t rs ho e ref rred to jl f tl t rm marri g a recog ised right j r t cted l th tribe

If ndirect f ce n fa f tl bel f f tl f m pre al nce f communal mar riag fro nd rest l fly o tl t rm f l t a l p wl h are mpl ed between th m mbers f tl sam tribe mpl a connection w th tl t be and t w tl tl r pare t B t tl bject is too larg and u pl f n an ab tract to be h re g n, and I w ll co fi my lf to f w remarks. It d t th case of h mar g s o wl re tl mar g t is lhouse th t th rela t n l p of th h ld t t f th cam r l e k wn B t t seems lmo t red bl th t tl relatio l p of tl child to its m th h ld be compl t ly gno ed pec all as the w m n n most sa g tribe nurse tl n

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l ation f t mals and Plants nder Dom sti- cation, ol p. 207

J Lubbock, *The Orign of C vilisation*, 1870, hap m especially pp 60-67 M M Le nan,

lassificat y t m of relatio h p. (I rocee g *the Amer ca cademy of Sci nce* L m h b 1868, p. 4) concludes that pol yamy nd ll f rms of marriage during pr me l times re s- se tiall nknow It ppears lso from Sir J Lubbock work, that Bachof l le ise belie es that comm nal nt rcourse r g nall pre ailed

CHAPTER XX

SECONDARY SEXUAL CHARACTERS OF MAN—*Continued*

We have seen in the last chapter that with all barbarous races ornaments dress and external appearance are highly valued and that the men judge of the beauty of their women by widely different standards We must next inquire whether this preference and the consequent selection during many generations of those women which appear to the men of each race the most attractive has altered the character either of the females alone or of both sexes With mammals the general rule appears to be that characters of all kinds are inherited equally by the males and female we might t[illegible]fore expect that with mankind any char [illegible]

[illegible]

certain that the different races would be differently modified as each has its own standard of beauty

With mankind especially with savages many causes interfere with the action of sexual selection as far as the bodily frame is concerned Civilised men are largely attracted by the mental charms of women by their wealth and especially by their social position for men rarely marry into a much lower rank The men who succeed in obtaining the more beautiful women will not have a better chance of leaving a long line of descendants than other men with [illegible] the few who bequeath [illegible]

namely of the more attractive men [illegible] women although in civilised nations women have free or almost free choice which is not the case with barbarous races yet their choice is largely influenced by the social position and wealth of the men and the success of the latter in life depends much on their intellectual power [illegible] or on the fruit of these same [illegible] neede[illegible] for as [illegible] remarks the final aim of all love intrigues be they comic or tragic is really of more importance than all other ends in human life What it all turns upon is nothing less than the composition of the next generation It is not the weal or woe of any one individual but that of the human race to come which is here at stake [1]

There is however reason to believe that in certain civilised and semi civilised nations sexual selection has effected something in modifying the bodily frame of some of the members Many persons are convinced as it appears to me with justice that our aristocracy including under this term all wealthy families in which primogeniture has long prevailed from having chosen during many generations from all classes the more beautiful women as their wives have become [illegible] and [illegible] to the European standard [illegible]

of life for the perfect development of [illegible] Cook remarks that the superiority in personal appearance which is observable in the erees or nobles in all the other islands (of the Pacific) is found in the Sandwich Islands but this may be chiefly due to their better food and manner of life

The old traveller Chardin in describing the Persians says their blood is now highly re[illegible] [illegible] mixtures with the [illegible]

is hardly a man of rank in Persia [illegible] born of a Georgian or Circassian mother He adds that they inherit their beauty not from their ancestors for without the above mixture the men of rank in Persia who are descendants of the Tartars would be extremely ugly [2] Here is a more curious case the priestesses who attended the temple of Venus Erycina at San Giuliano in Sicily were selected for their beauty out of the whole of Greece they were not vestal virgins and Quatrefages who states the foregoing fact says that the women of San Giuliano are [illegible]

[1] [illegible] Jo[u]r[n]al [illegible]

[illegible]

[2] [illegible] Rev[u]e d[es] Co[urs] Scientifique Oct 1868 p 721

hat social th chimpanzee for nstance, is occasionally met with in larg bands. Again, other species are pol gam us, but sev ral males, each with his n femal s, l asso-ciated in body as with se eral peci s of baboons. W may indeed con lud from what we know of th j alo y of all male quadru peds, armed, as many f them are w th pecial eapons f b ttling with th ir ri als, that promiscu us intercourse in a tat f n ture is extrem ly improbable. The pairi g may n t ast for life, b t nly f ach b rth yet if the males which are th strongest and be t abl to defend r therwise assist th ir f mal s and oung, were t select th m re att acti e fe-males, this w uld suffice f sexual selecti n.

Theref re, looking far n gh back in th stream of time, and judging from th social hab ts of man as h n w xi ts, the m t prob-able vi w is that h aboriginally li ed in mall communiti s, each with singl wif if po ri l with se al, wh m he j al u ly guarded gainst all th m n. O h may not ha bee social animal, and y t ha h ed with se ral wi es, lik th g rilla f all th nati gree th t b t n adult male is seen in band wh n th y ung mal grows up a co test takes place f ma t ry and th stro est, by killing and drivin ut th thers, establish himself as th h ad of th communit [2] Th ung males, be g thus xpelled and wand ring abo t, w uld, wh n t last ccessful in findi g p rtn pre nt too lose inte breeding within th limits of the same family

re n w trem ly h

that death al n can separate husband and wif An int llig nt Kandyan chi f of course a pol gamist, was *perfectly* scandalised at th utter barbari m of l ng w th onl one wif and n r parting unt l separ ted by death. It was, he said just l k the Wan d oo m nk " Wh ther sa ages wh now nt r nto som f rm of marriage ther polygamou o mon gam us, ha e retained this hab t from prim val times, r wh ther they l returned to some form of marriage aft passing through tag f prom scuous int rcourse I will not pret nd to conjecture

I f nt cide —Thi p actice is now erv comm n throu h ut the w ld and there reason t beli that t pre ailed mu h m re t ns l during f rm tim [3] Barbarians find t difficult to pport tl msel and th ir children, and t is a simpl plan to kill tl eir nfants. In South America som tribes, ac cording to Azara, f rm l d troyed so many infants of both se es that th y w re n the point of extin ti n. In th Polyn sian Island w m n h been kn wn to kill from f ur or fi to en ten of th h ldren and Ellis could n t find ingle w man who had n t killed at l ast In a ill g on th astern front of India Col n l MacCulloch f und n t m l f mal ch ld Wh re nfant cid pre ails the truggl f exist nce will be in so far l ss sev re, d all th m mbers of th tribe will ha e an almost equally good chance f rearing th f w rvivin children. In m t case larg numbe of f mal than of mal infants are destroyed f t is b us that th latte are f m re alu to th tribe will wh n grown p aid n d f nding

ilised nations. P l gam as just ... almost uni rsall f ll wed b th l ading m ry tribe N rth l ss th re are tribes, standing alm t t th bottom f th scale hich are tri tl m gam s. This is the case with th Veddahs f Ce l n they ha sa ing, according to Sir J Lubbock,

high tim ti n set n th m wh n th happ f te, are assigned by th w m n th msel es, and by ari us bserv rs, as addi ti nal m ti es f infanticide.

Wh n, wing t f mal infanticide th

Brehm (*Illustrirtes Thierleben*, B i., p. ...) says *Cynocephal hamadryas* li es in gre t troops con-taining twice as many adult f males as adul males. See Rengger America pol gamous pecies, and Owen (*Anatomy f Vertebrates*, ol. iii., p. 46) American m nogamous pecies. Othe ref rences might be added.

[2] Dr Sa age, in *Boston Journal of Nat. Hist.* ... ol. 1845-4 p. 423.

Pr historic T mes 1869 p. 424.

[3] M M Lennan, *Primiti Marriage*, 1865 See especially gamy and inf ticide, pp 130 138,

this book correct quotatio from ... was unfortunat ly gi the bov passag and has w been remo ed from th text.

fants for a long time Accordingly in many cases the lines of descent are traced through the mother alone to the exclusion of the father But in other cases the terms employed express a connection with the tribe alone to the exclusion even of the mother It seems possible that the connection between the related members of the same barbarous tribe exposed to all sorts of dange[illegible]

[illegible] caution as to lead to the sole use of terms expressive of the former relationships but Mr Morgan is convinced that this view is by no means sufficient

The terms of relationship used in different parts of the world may be divided according to the author just quoted into two great classes the classificatory and descriptive — the latter being employed by us It is the classificatory system which so strongly leads to the belief that communal and other extremely loose forms of marriage were originally universal But as far as I can see there is no necessity on this ground for believing in absolutely promiscuous intercourse and I am glad to find that this is Sir J Lubbock s view Men and women like many of the lower animals might formerly have entered into strict though temporary unions for each birth and in this case nearly as much confusion would have arisen in the terms of relationship as in the case of promiscuous intercourse As far as sexual selection is concerned all that is required is that choice should be exerted before the parents unite and it signifies little whether the unions last for life or only for a season

Besides the evidence derived from the terms of relationship other lines of reasoning indicate the former wide prevalence of communal marriage Sir J Lubbock accounts for the strange and widely extended habit of exogamy—that is the men of one tribe taking wives from a distinct tribe —by communism having been the orig nal fo[illegible]

[illegible] come his sole and valuable property Thus the practice of capturing wives might have arisen and from the honour so gained it might ultimately have become the universal habit According to Sir J Lubbock [6] we can also thus understand the necessity of expiation for marriage as an infringement of tribal rites since according to old ideas a man had no right to appropriate to him elf that which belonged to the whole tribe Sir J Lubbock further gives a curious list of facts shewing that in old times high honour was bestowed on women who were utterly licentious and this, as he explains is intelligible if we admit that promiscuous intercourse was the aboriginal and therefore long revered custom of the tribe [7]

Although the manner of development of the marriage tie is an obscure subject as we may infer from the divergent opinions on several points between the three authors who have studied it most closely namely Mr Morgan Mr M Lennan and Sir J Lubbock yet from the foregoing and several other lines of evidence it seems probable[8] that the habit of marriage in any strict sense of the word has been gradually developed and that almost promiscuous or very loose intercourse was once extremely common throughout the world Nevertheless from the strength of the feeling of jealousy all through the animal kingdom as well as from the analogy of the lower animals more particularly of those which come nearest to man I cannot believe that absolutely promiscuous intercourse prevailed in times past shortly before man attained to his present rank in the zoological scale Man as I have attempted to shew is certainly descended from some ape like creature With the existing Quadrumana as far as their habits are known the males of some species are monogamous but live during only a part of the year with the females of this the orang seems to afford an instance Several kinds for example some of the Indian and American monkeys are strictly monogamous and associate all the year round with their wives Others are polygamous for example the gorilla and several American specie and each family lives separate Even when this occurs the families inhabiting the same district are probably some

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Orig f C vil t o 18 0 p 86 In tl [illegible] k b v q ted th ll b f n l cop s d e o l t a l p thr gh th f m l l th the t b l

Mr C Stan land W ke gues t o gly (*J th pol g* M l [illegible]

that social; the chimpanzee for instance is occasionally met with in large bands. Again, other species are polygamous, but several males, each with his own females, live associated in a body, as with several species of baboons. We may indeed conclude from what we know of the jealousy of all male quadrupeds, armed, as many of them are with special weapons for battling with their rivals, that promiscuous intercourse in a state of nature is extremely improbable. The pairing may not last for life, but only for each birth; yet if the males which are the strongest and best able to defend or otherwise assist their females and young, were to select the more attractive females, this would suffice for sexual selection.

Therefore, looking far enough back in the stream of time, and judging from the social habits of man as he now exists, the most probable view is that he aboriginally lived in small communities, each with a single wife, or if powerful with several, whom he jealously guarded against all other men. Or he may not have been a social animal, and yet have lived with several wives, like the gorilla; for all the natives agree that but one adult male is seen in a band; when the young male grows up, a contest takes place for mastery, and the strongest, by killing and driving out the others, establishes himself as the head of the community.[20] The younger males, being thus expelled and wandering about, would, when at last successful in finding a partner, prevent too close interbreeding within the limits of the same family.

Although savages are now extremely licentious, and although communal marriages may formerly have largely prevailed, yet many tribes practise some form of marriage, but of a far more lax nature than that of civilised nations. Polygamy, as just stated, is almost universally followed by the leading men in every tribe. Nevertheless there are tribes, standing almost at the bottom of the scale, which are strictly monogamous. This is the case with the Veddahs of Ceylon: they have a saying, according to Sir J. Lubbock,[21] that death alone can separate husband and wife. An intelligent Kandyan chief, of course a polygamist, "was perfectly scandalised at the utter barbarism of living with only one wife, and never parting until separated by death. It was, he said, just like the Wanderoo monkeys." Whether savages who now enter into some form of marriage, either polygamous or monogamous, have retained this habit from primeval times, or whether they have returned to some form of marriage after passing through a stage of promiscuous intercourse, I will not pretend to conjecture.

Infanticide.—This practice is now very common throughout the world, and there is reason to believe that it prevailed much more extensively during former times.[22] Barbarians find it difficult to support themselves and their children, and it is a simple plan to kill their infants. In South America some tribes, according to Azara, formerly destroyed so many infants of both sexes that they were on the point of extinction. In the Polynesian Islands women have been known to kill from four or five to even ten of their children; and Ellis could not find a single woman who had not killed at least one. In a village on the eastern frontier of India Colonel MacCulloch found not a single female child. Where infanticide prevails the struggle for existence will be in so far less severe, and all the members of the tribe will have an almost equally good chance of rearing their few surviving children. In most cases a larger number of female than of male infants are destroyed, for it is obvious that the latter are of more value to the tribe, as they will, when grown up, aid in defending it, and can support themselves. But the trouble experienced by the women in rearing [illegible] tional motives for infanticide.

When, owing to female infanticide, the

[19] Brehm (*Illustriertes Thierleben*, B. i., p. 77) says *Cynocephalus hamadryas* lives in great troops containing twice as many adult females as adult males. See Rengger on American polygamous species, and Owen (*Anatomy of Vertebrates*, vol. iii., p. 746) on American monogamous species. Other references might be added.

[20] Dr. Savage, in *Boston Journal of Natural History*, vol. v., 1845-7, p. 423.

[21] *Prehistoric Times*, 1869, p. 424.

[22] Mr. M'Lennan, *Primitive Marriage*, 1865. See especially on exogamy and infanticide, pp. 130, 138, 165.

[23] Dr. Gerland (*Ueber das Aussterben der Naturvölker*, 1868) has collected much information on infanticide, see especially ss. 27, 51, 54. Azara (*Voyages, &c.*, tom. ii., pp. 94, 116) enters into detail on the motives. See also M'Lennan (*ibid.* p. 139) for cases in India. In the former reprints of the 2nd edition of this book an incorrect quotation from Sir G. Grey was unfortunately given in the above passage, and has now been removed from the text.

women of a tribe were few the habit of capturing wives from neighbouring tribes would naturally arise Sir J Lubbock however as we have seen attributes the practice in chief part to the former existence of communal marriage and to the men having consequently captured women from other tribes to hold as their sole property Additional causes might be assigned such as the communities being very small in which case marriageable women would often be deficient That the habit was most extensively practised during former times even by the ancestors of civilised nations is clearly shewn by the preservation of many curious customs and ceremonies of which Mr M Lennan l

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ice and craft they would have been glad to seize on any woman and would not have selected the more attractive ones But as soon as the practice of procuring wives from a distinct tribe was effected through barter as now occurs in many places the more attractive women would generally have been purchased The incessant crossing however between tribe and tribe which necessarily follows from any form of this habit would tend to keep all the people inhabiting the same country nearly uniform in character and this would interfere with the power of sexual selection in differentiating the tribes

The scarcity of women consequent on female infanticide leads also to another practice that of polyandry still common in several parts of the world and which formerly as Mr M Lennan believes prevailed almost universally but this latter conclusion is doubted by Mr Morgan and Sir J Lubbock When ever two or more men are compelled to marry one woman it is certain that all the women of the tribe will get married and there will be no selection by the men of the more attractive women But under these circumstances the women no doubt will have the power of choice and will prefer the more attractive men Azara, for instance describes how carefully a Guana woman bargains for all sorts of privileges before accepting some one or more husbands and the men in consequence take unusual care of their personal appearance So amongst the Todas of India, who practise polyandry the girls can accept or refuse any man [1] A very ugly man in these cases would perhaps altogether fail in getting a wife or get one later in life but the handsomer men although more successful in obtaining wives, would not, as far as we can see leave more offspring to inherit their beauty than the less handsome husbands of the same women

Early Betrothals and Slavery of Women — With many savages it is the custom to betroth the females whilst mere infants and this would effectually prevent preference being exerted on either side according to personal appearance But it would not prevent the more attractive women from being afterwards stolen or taken by force from their husbands by the more powerful men and this often happens in Australia America and elsewhere The same consequences with reference to sexual selection would to a certain extent follow when women are valued almost solely as slaves or beasts of burden as is the case with many savages The men however at all times would prefer the handsomest slaves according to their standard of beauty

We thus see that several customs prevail with savages which must greatly interfere with or completely stop the action of sexual selection On the other hand the conditions of life to which savages are exposed and some of their habits are favourable to natural selection and this comes into play at the same time with sexual selection Savages are known to suffer severely from recurrent famines they do not increase their food by artificial means they rarely refrain from marriage [2] and generally marry whilst young Consequently they must be subjected to occasional hard struggles for existence and the favoured individuals will alone survive

At a very early period before man attained to his present rank in the scale many of his conditions would be different from what now obtains amongst savages Judging from the analogy of the lower animals he would then either live with a single female or be a polyga

I n t M rriage p 208 S J Lubbock *Orig n f C ulis t n*, p 100 S lso M M g *loc cit* n th f m pre lence f poly nd y

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p 55) tl s tl ld t f so th n Af ca t th pa th r l t t f l b y l r (l y g d nsl' Amériq e M d t 1809 p 21) m k p c ely th sa m rk n reg rd t the w ld I d f South Am ca.

mst. The most powerful and abl males would succeed best in obtaining attracti f males. They would also succeed best in th ge ral struggle for lif and in d f nding th fe- males, as w ll as their off pring, from m m es of all kinds. At this arly period the ancest rs of man w uld t be ffici ntl ad anced in intellect to look forward t di tant co tingencies the w uld not f resee th t th rear ng of all their children, especiall the r f male children, would mak th truggle f life severer for th tribe. Th y w uld be go rned more by their nstin ts and less by th r reason than are sa t the prese t da Th y ould not t that period ha partiall lo t one of th stronge t of all instin ts, comm n to all the low r animals, namel th l ve of heir own off p r and conseq ntl th y would not ha practised f male infanticide Women would n t ha been thus rend red scarce and polyandry w ld n t ha e been practised for hardly any oth a se cept the scarcit of w m n seems ffici t to break d th natural and wid l pre ale t feeling of jealous and th des re of ach mal to possess femal f himself Pol andry w uld be natural t ppin t to com munal marria es almost promisc nt course thou th be t thoriti s beli that th latt l b t preceded pol andry Durin primordial times th re w ld be n earl betrothals, for this impl f resigh t. would w m n be al d m ly as ss l as m or beast of burd n. Both se es, f th f males as ll as th males w re permitted to ert an h ce w d hoose their partn rs not for me tal charms, prope t social position, b t almost sol l from xt rnal p- pearance All the adults w uld marry pai and all the off pring, as far as that was pos- sible would be reared so that th truggl f existence uld be periodicall xcess ly se re Thus d ri g th se tim all th condi- tions for se ual selecti w uld ha been m re f ourable than t late period when man had ad anced in his intellectual powers b t had retrograded hi nstincts. Th refore, what

infl nce se al selecti m ha had in producing th diff rences betwe th races of man, and betwee man nd th highe Quad rumana, th infl nce w ld h been more po rful t remot period than t th present d y though probabl not t wholly lost.

The M nner f Action f Sexual Selection with Mankind.—W th primeval man under

th th n p]

infanticid arly betrothals, a and most gorous m n—those w o could best d f nd and hunt f r th ir famil es, who w re pro ded with the best w apons and pos- sessed th m t property h as a large num ber of d gs o othe animals,—w ld s cceed in rearin a great a rage n mber of off sprin th n th e weak and poorer m mbers of th same tribes. There can also be no do bt that such men w uld gen rall be able to select th m re ttract w men At pres- ent th ch fs of nearl ery tribe thro h t th w ld ceed in obtainin more tha o e wif I hear from M Mant ll that, unt l re- ce tl almost e ry gi l in N w Ze land w o was prett promised to be pretty was t f W if th Kaffirs, as M C

ach race has its own t le of beaut and e kn w th t t is n tural to man to admire ach charact r it c point n h d mesti animals, dress, ornam ts, and personal appearance when carried a ttle be nd th a erage If th n th se ral foreg in propositi n be ad mitted and I cann t see th t th are d ubt ful, t w ld be an in pl cabl rc mstance if th select n f th n re ttract w m n b th more po rful m n of each t ibe who w uld rear o an era a gre t numbe of children, did not aft the lapse f many g rations som what modif th charact r f the tribe

Wh n f re gn breed of ou d mestic ani mals is introd ced int n w coun ry o wh n a nati breed is lo g and carefully tt ded to, th f use o man at t is f und aft se ral g n ratio to ha und rg e a gre t less am unt of chan wh e th means of comparison xist. This f ll w from u conscious selecti n during lo seri f g nerati ns—that is, th preser ti n of th most ppro ed ndi id als—without any wish pectation of ch a result n th part of th breed So again, if during man ars tw careful breed rs rear animals of th sam family and d n t compare th m t g ther or with a comm n standard, th animals are

Anthropological Review Jan., 1870, p. xvi.

found to have become to tl

of his own mind—his own taste and judgment—on his animals What reason then can be assigned why similar results should not follow from the long continued selection of the most admired women by those men of each tribe who were able to rear the greatest number of children? This would be unconscious selection for an effect would be produced independently of any wish or expectation on the part of the men who preferred certain women to others

Let us suppose the members of a tribe practising some form of marriage to spread over an unoccupied continent they would soon split up into distinct hordes separated from each other by various barriers and still more effectually by the incessant wars between all barbarous nations The hordes would thus be exposed to slightly different conditions and habits of life and would sooner or later come to differ in some small degree As soon as this occurred each isolated tribe would form for itself a slightly different standard of beauty and then unconscious selection would come into action through the more powerful and leading men preferring certain women to others Thus the differences between the tribes at first very slight would gradually and inevitably be more or less increased

With animals in a state of nature many characters proper to the males such as size strength special weapons courage and pugnacity have been acquired through the law of battle The semi human progenitors of man like their allies the Quadrumana will almost certainly have been thus mod

t day Other characters proper to the males of the lower animals such as bright colour and various ornaments have been acquired by the more attractive males having been preferred by the females There are however exceptional cases in which the males

r are the selectors instead of having been the s selected We recognise such cases by the females being more highly ornamented than the males —their ornamental characters having been transmitted exclusively or chiefly to their female offspring One such case has been described in the order to which man belongs, that of the Rhesus monkey

Man is more powerful in body and mind than woman and in the savage state he keeps her in a far more abject state of bondage than does the male of any other animal therefore it is not surprising that he should have gained the power of selection Women are everywhere conscious of the value of their own beauty and when they have the means they take more delight in decorating themselves with all sorts of ornaments than do men They borrow the plumes of male birds with which nature has decked this sex in order to charm the females As women have long been selected for beauty it is not surprising that some of their successive variations should have been transmitted exclusively to the same sex consequently that they should have transmitted beauty in a somewhat higher degree to their female than to their male offspring and thus have become more beautiful according to general opinion than men Women however certainly transmit most of their characters, including some beauty to their offspring of both sexes so that the continued preference by the men of each race for the more attractive women according to their standard of taste will have tended to modify in the same manner all the individuals of both sexes belonging to the race

With respect to the other form of sexual selection (which with the lower animals is much the more common) namely when the females are the selectors and accept only those males which excite or charm them most

characters to

distance from an ancient progenitor who thus gained his ornaments But this form of selection may have occasionally acted during later times for in utterly barbarous tribes the women have more power in choosing rejecting and t

tribes of Arctic Am rica repeatedly ran away from h r husband and j ined h r l r and with the Charr as f S Am rica, according to Azara, di rce is quite pt nal. Amo g t th Ab pones, man n choosi w f h gains with the parents bo t th price B t t fre que tl h t th g l rescind wl t has be the h me t hales C t te

Leslie who was intimat ly acquainted with the Kaffirs, says, it i a mi tak to imagine that g rl is sold by he father in the same manne and w th th same th r ty with wh ch he w ld dispose of a cow Am ng t th d of S Africa, wh n a g l l h n t prob t as w ll as that of tr e pare Mr W wood Reade mad inquiri s f m w th pect to th n groes f we t rn Africa, and he inf rms me that th women at least m ng th m re int ll g t pag n tribes, I a e ls wh m

Tierra del F g a g man first btai ti conse t f the pare ts b d g th m som ser ce and th h tt mpts t rr ff th g l "b t if sh u w ll g h l d h rself in th woods unt l h adm re h art f t red of looking f he and gi p tl p rs t b t this seld m happens I th F j I land th man se ze o th w man wh m b w h for his wif by act al pret nded f rce but reachi g th l m f h abd t h ld sh t ppro f th m t h h ru to som ne ho an protect h lf h w h satisfied th m tt settled f thw th W th th Kalm ks th reg lar ace be t een th b d d brid g oom, th f m ha ing a fai start and Clark was ass red that no in tance occ f g l be ca ght, unl ss h has part lit t th p rs Am gst th wild tribe f th Mala Archi pelag th re lso racing mat h and t p pears from M B account, as Sir J Lubbock remarks, that th ace n t to th swift, tl b ttl t th tro g but t th g man wh l as th good f rtun t pl ase his int nded brid A m l cust m w th th tam re lt pre ails w th th K raks f north r m A

are forming tend r pass nate, and faithfu tachm ts. Addit nal cases co ld be gi n. W thu see th t with sa es th w m n are t n qu t so abject a tat in lat n to m rri g as has oft n been pposed They can t mpt th m n wh m the prefe and can som tim r ject those wl m th y dislike th r bef re aft ma ri g I ref r ce on the part f the w m n, teadily acti g n any n d recti n, w uld ultim t ly affect the haract f th tribe f the w m n would g n rally hoose n t m rely the l ndsom t m n, accord g t th ir tandard f tast b t th se wh w re at th sam tim be t abl to d f d and ppo t th m. S ch w ll-end wed pairs w uld comm nly rear a larg r n mbe of ff p ing than th les f red Th sam re sult w uld b ly f ll w in a t ll m re marked mann if th re was selecti n n both id that is, f th m ttract and at th e sam t m m pow f l m n w re to p f and w re pref rred by th m re tt act e w m n And th d bl f rm of selecti n seems act ally t ha occurred pecially during th arl period f ur l g hi tory

band b t mand t from many facts gi n b th Re M Shoot th t th ha co

xhib t th ir paces. Th y ha been known to propose to a man, and th y n t rarely run w y w th f red lo er So again, M

We will now examine a little more closely some of the characters which distinguished the several races of man from one another and from the lower animals namely the greater or less deficiency of h

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ave out we l aus of judging whether they have been acted on chiefly from the male or female side The musical faculties of man have likewise been already discussed

Absence of Hair on the Body and its Development on the Face and Head —From the presence of the woolly hair or lanugo on the human fœtus and of rudimentary hairs scattered over the body during maturity we may infer that man is descended from some animal which was born hairy and remained so during life The loss of hair is an inconvenience and probably an injury to man even in a hot climate for he is thus exposed to the scorching of the sun and to sudden chills especially during wet weather As Mr Wallace remarks the natives in all countries are glad to protect their naked backs and

therefore cannot have been divested of hair through natural selection [2] Nor as shewn in a former chapter have we any evidence that this can be due to the direct action of climate or that it is the result of correlated development

The absence of hair on the body is to a certain extent a secondary sexual character for in all parts of the world women are less hairy than men Therefore we may reasonably suspect that this character has been gained through sexual selection We k that t faces of several species of monkeys and large surfaces at the posterior end of the body of other species have been denuded of hair and thus we may safely attribute to sexual selection for these surfaces are not only vividly coloured but sometimes as with the male mandrill and female rhesus much more vividly in the one sex than in the other especially during the breeding season I am informed by Mr Bartlett that as these animals gradually reach maturity the naked surfaces grow larger compared with the size of their bodies The hair however appears to have been removed not for the sake of nudity but that the colour of the skin may be more fully displayed So again with many birds it appears as if the head and neck had been divested of feathers through sexual selection to exhibit the brightly coloured skin

As the body in woman is less hairy than in man and as this character is common to all races we may conclude that it was our female semi human ancestors who were first divested of hair and that this occurred at an extremely remote period before the several races had diverged from a common stock Whilst our female ancestors were gradually acquiring this new character

t has not been limited either by sex or age There is nothing surprising in a partial loss of hair having been esteemed as an ornament by our ape like progenitors for we have seen that innumerable strange characters have been thus estee

L acquired for we know that this is the case with the plumes of certain birds and with the horns of certain stags

The females of some of the anthropoid apes as stated in a former chapter are somewhat less hairy on the under surface than the males and here we have what might have afforded a commencement for the process of denudation With respect to the completion of the process through sexual selection it is well t

au to bribe a man to marry the first hairy woman in the family and she trans-

[2] Cont b t o t th Th y f N t l S l t 18 (p 3 0) th t d t t th l t l l
It T R Stebb g t m nt tl (Tr sactio f Devo l t oc t f S 18 0) r m rks th t l d M W ll n l y d h l l ss y f ts sel c h lth t

mitted th baract r to b r v ng off pri g of both sexes.[23]

Sor re m h m rel airs tl tl ers, pec me E l

ll l s first eq ired the r beards t ro h l select n as an orn me t, tran m tt g tl m m l ase equ lly o ne ly so to ll ff p ng f b tl se W kn w from l tl t with m nk l tl f m le as

al ys pt t ret W l see tl t d ts re ften y l airs and tl y t t re rt h h t rs t al m l t pe It p g t rs f wl both se re beard ... bt probabl

of b rd see t l e been int rited f wl h rog t f wl tl re is

be th re lt f re rs lecked by any f rm l select t t m ar b l ty thus th l m t f tl sa are cease t be remarkabl.[24] b rd tl tl t f tl f l t f lly de l ped l t m t mt y t as w tl n l

W th re pect t th b ard m f w tu n t ur be t g d tl Q ad m na, w fi d be rd q ll d l ped b tl se f m pec b t so tl co fined t tl males, m re d l ped tl tl an n th f m l s. From tl f t d fro tl rn fact f t g t a ab l t d ffere t ce ard w tl tl sam ce f r tl nd cat re rs —l g l t h act rs be g pt t n re-appearance

N m t w e look tl pa t wl l sexual lect n m y l e g l ed in l ter tim f w kn tl t w tl sa tl e m n f tl be rdl ss race tak fi t pains n ad t g rs h from tl f ce as som th g odio s, wl l t tl m f tl b rded race feel tl gre t t prid tl b rds. Th w m n d lt pa t cipat th se feelings, and f so se l select n an l rdly l f led t l ff ted som tl g in tl co rs f l t t m s. It lso poss bl th t tl l g-c t ed l b t f ad t tl h m l p o- d ced n al nt d ff ct Bro n-Se q ard has sl tl t f certain animals re pe t d p rt l mat th ff p g re ff ted l d co ld b g f tl l t ce f tl ffect f m t l t b t f t l t l asce tained by M Sal n[25]

character f h ea ly pe l k proge tors.

[23] ... It has t th m t l d ... D Fortsch ... (p 50) th bo ... th loss of ha ... through sexual selec ... of th pposed argume ts seem ... ght, co pa so h the f h g that tl ... ty of th ... cert ... secondary sexual characters ... and some of the Quadrumana.

[24] Ueber d R ht gd Haare m M schl h Körpe Müller A h f A at nd Phys. 1837, s. 40

[25] On the tad f thers f Mom ts, Proceed ... the Zoological Society 18 5, p. 429

We will now examine a little more closely some of the characters which distinguished the several races of man from one another and from the lower animals namely the greater or less deficiency of hair on the body and the colour of the skin We need say nothing about t t di ersity in the shape of the features

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wet weather As Mr Wallace natives in all countries are glad to protect their naked backs and shoulders with some slight covering No one supposes that the nakedness of the skin is any direct advantage to man his body therefore cannot have been divested of hair through natural selection [21] Nor as shewn in a former chapter have we any evidence that this can be due to the direct action of climate or that it is the result of correlated development

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sex or age There is nothing surp partial loss of hair ha ing been e teemed as an ornament by our ape like progenitor for we have seen that innum erable strange characters have been thus esteemed by animals of all kinds and have consequently been gained through sexual selection Nor is it surprising that a slightly injurious character hould have been thus acquired for we know that this is the case with the plumes of certain birds and with the horns of certain stags

The females of some of the anthropoid apes as stat d in a former chapter are somewhat rface than the males

With e pect to the compl through sexual selection it ll to bear in mind the New Zealand prov rb There is no woman for a hairy man All o have seen photographs of the Siam se hairy family will admit how ludicrou ly hideous is the opposite extreme of excessive hairine s And the king of Siam had to bribe a man to marry the first hairy woman in the family and she trans-

[21] Co 1870 s m de l co d t Re (Tran 18 0) usual skin he might h v s tin thr ugh ts up or be uty r the he lth t taching to super or cleanl ness

females were modified in th r respects fo the same purpose and by the same m ans so that women have acquired sweet r v ces and become more beautiful than men.

It deserves ttention that with mankind th conditions were in many respects much m re favourable for sexual selection during a v ry early period, when man had nly just attained to the rank of manhood, than during later times. For h w uld then, as we may safely conclude, ha been guided more b his instinctive passions, and less by f resight or reason. H w uld ha j alously guarded his wif or wi es. H w uld n t ha practised in fanticide nor val ed his wi m rely as useful slaves nor ha e been betrothed to th m during infancy Hence we may inf th t th races of men were differentiated, as far as sexual selection is concerned, in chief part at a very remote epoch and this conclus n throws light on th remarkabl fact that t th most ancient period, of which w ha e not as y t an record, the races of man had already come to differ nearly or quit as much as th y do at the present day

The views here advanced n the part which sexual selection has pla ed in th history of man, want scientific precisi n. H wh does not admit this a ncy in th case of the low animals, will disregard all that I ha e written n th lat chapters on man We cannot positi ely say that this character but n t that, has been thus modified it has l ow v r been sh wn that th races f man diff r from ach th r and from th ir nearest allies, in certain characters which are f no service to th m in th ir daily hab ts f life, and whi h t is trem ly probabl w uld hav been modified thro gh sexual selection. We ha e seen that with th lowest sa ages the people of ach tribe admire thei own characteristic qualities,—th shape f th head and face the squareness of th cheek-bones, the prominence o d pression of the nose the col ur of the skin, th len th of th hair on the head the absence of hair on th face and bod o the presence of a gre t beard, and so forth. H nce these and th r uch points could hardl fail t be slowly and gradually exaggerated from the m re powerful and abl men in ach tribe who w uld ucceed in rearing th largest number of off pring, having selected durin many g n rati ns f r th ir w es th most trongly characterised and th refore most attracti w men. For my wn part I conclud that f all the causes which have led to the differences in ext rnal ppearance between the races of man, and to a certain extent between man and th lower animals, sexual selection has been th mo t efficient.

has a more direct be

aturally somewhat reduced [27] Nevertheless with mankind the habit of eradicating the beard and the hairs on the body would probably not have arisen until these had already become by some means reduced

It is difficult to form any judgment as to how the hair on the head became developed to its present great length in many races Eschricht[28] states that in the human fœtus the hair on the face during the fifth month is longer than that on the head and this indicates that our semi human progenitors were not furnished with long tresses which must therefore have been a late acquisition This is likewise indicated by the extraordinary difference in the length of the hair in the different races in the negro the hair forms a mere curly mat with us it is of great length and with the American natives it not rarely reaches to the ground Some species of Semnopithecus have their heads covered with moderately long hair and this probably serves as an ornament and was acquired through sexual selection The same view may perhaps be extended to mankind for we know that long tresses are now and were formerly much admired as may be observed in the works of almost every poet St Paul says if a woman have long hair it is a glory to her and we have seen that in North America a chief was elected solely from the length of his hair

Colour of the Skin —The best kind of evidence that in man the colour of the skin has been modified through sexual selection is scanty for in most races the sexes do not differ in this respect and only slightly as we have seen in others We know however from the many facts already given that the colour of the skin is regarded by the men of all races as a highly important element in their beauty so that it is a character which would be likely to have been modified through selection as has occurred in innumerable instances with the lower animals It seem at first sight a monstrous supposition that the jet blackness of the negro should have been gain d through

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[28] *Über die Richtung* &c p 40

sexual selection but this view is supported by various analogies and we know that negroes admire their own colour With mammals when the sexes differ in colour the male is often black or much darker than the female and it depends merely on the form of inheritance whether this or any other tint is transmitted to both sexes or to one alone The resemblance to a negro in miniature of *Pithecia satanas* with his jet black skin white rolling eyeballs and hair parted on the top of the head is almost ludicrous

The colour of the face differs much more widely in the various kinds of monkeys than it does in the races of man and we have some reason to believe that the red blue orange almost white and black tints of their skin even when common to both sexes as well as the bright colours of their fur and the ornamental tufts about the head have all been acquired through sexual selection As the order of development during growth generally indicates the order in which the characters of a species have been dev l

as much in colour as do the adults although their bodies are as completely destitute of hair we have some slight evidence that the tints of the different races were acquired at a period subsequent to the removal of the hair which must have occurred at a very early period in the history of man

Summary —We may conclude that the greater size strength courage pugnacity and energy of man in compa i on with woman were acquired during primeval times and have subsequently been augmented chiefly through the contests of rival males for the possession of th females The greater intellectual vigour and power of inv ntion in man is probably due to natural selection com bined with the inherited effects of habit for the most abl men will have succeeded best in defending and providing for themselves and for their wive and offspring As far as the

charm or excite the opposite sex and transmitted them only to their male offspring The females apparently first had their bodies denuded of hair also as a sexual ornament but they transmitted this character almost equally to both sexes It is not improbable that the

cannot be accounted f by any f rm of selection, or by th inherited ffects f th use and disuse of parts. W kn w howe er th t man strange and strongly marked peculiarities of structure occasionall ppear in our d mesticated productions, and if their unkn wn causes ere to act more unif rmly th y w ld probably becom comm to all the indi iduals f the species. We may hope h reaft t understand som thing abo t th cause f uch occasional modifications, especially through th stud of monstrositi h nce th labours of experimentalists such as those f M. Camille Dareste, are full of promise f r th f t In general w can nly sa that th cause f ach light ariation and f ach m nstro ty l es much more in the con titut n of th rganism, than in the n ture of th surrounding conditions th gh new and ha ged cond t ns certainly pla an mportant part in xciting organic chan f man kinds.

Thro gh th m ans just pecified aided perhap by th rs as t und sco red man has bee raised to his prese t tat Bu t since he ttained to th rank of manhood h has d rged into d t ct races, as th may be more fitly called, sub-species. Som of these such as th N gro and European, are so distinct that, if specim ns had been bro ght t

f rmat n,

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It must no be

of ach race from th th races, and f all from commo tock, can be t aced back t an pa of prog nitors. On th co trary at m tag in th process f modificati n, all th nd vid als who h w re in an w bet le fitted f th ir cond ti ns of lif tho gh in diff re t degrees, w ld ha urv ed in greater umbers than th l ss w ll fitted Th process w uld ha bee lik that f ll wed by man, wh h doe not intentionally select particular ndi iduals, b t breeds from all th perior ind iduals, and neglects th inf ri thus low l but urely modifi his tock, and unconscioul f rms a w train. So with respect to modificati ns acquired ind pendently of selection, and d t ariations arising from the ature of th organism and th acts n f th rrounding cond ti ns or from changed hab ts of life no single pair will ha e been modified much more than the th r pairs in hab ting th same co ntry for ll will ha e been continually bl nded thro gh free intercrossing

By consid ring the mbryological tructure of man,—the h mol gies which he presents w th th low r animals,—th rud m nts wh ch retains,—and the re ers ns to whi h he is liable we can partly recall n maginat n the form r conditi n of our early p og nit rs and can appro im t ly place th m in th r proper place in th zool gical seri We thus learn th t man is desce ded from a hairy tailed quadruped, probabl arboreal n hab ts, and an inhab tant of th Old W ld Thus creature if ts wh l structure had been examined by natural t, would ha e been lassed am ngst th Quadrumana, as urely as th till m re anci nt pro nito of the Old and N w W ld m nk s. Th Quadrumana and ll th high r mammals are probably deri ed from an anci nt marsup al animal and thus through lo g series f d rsified f rms from some amphib an like reature and thi a ain from som fish like animal. In the dim of scur t f th past w can see th t the early prog nito f all th V rteb ta m st ha be n an aq tic animal provided w th bran hiæ with th tw se s united n th sam nd d ual, and w th the m t mportant rgans f th body (ch as th brain and heart) mpe fectly o not t all de loped This animal seem to ha been m re l ke th larvæ of th xi t ng marin ascidians than any th r kn wn f rm.

Th high standard f ur intellectual po rs and m ral disposit s th gre t t difficulty which presents tself afte w ha been dri n to this co clus n n the rigin of man. But re wh admits th prin pl of lu ti n, must see that th m ntal pow rs of th high animals, which are th same in kind w th those of man, th gh so diff rent n degree, are capabl f ad ancem nt. Th u th interval between th m ntal pow rs of n f th high pe and of fish, o between those of an ant and scal insect, mm nse y t their d elopm nt does not off an pecial difficulty f with o r d mesticated an mals, th m ntal faculti are certainly variable and th ariati ns are inh rited. No on d ubts that th are of th utm t importance to animals in tat f nature. Th ref re th condi ti ns are f ourabl for th ir d elopment

CHAPTER XXI

GENERAL SUMMARY AND CONCLUSION

A

advanced are highly speculative and some no doubt will prove erroneous but I have in every case given the reasons which have led me to one view rather than to another It seemed worth while to try how far the principle of evolution
more co
of man
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do little harm for every one takes a salutary pleasure in proving their falseness and when this is done one path toward error is closed and the road to truth is often at the same time opened

The main conclusion here arrived at, and now held by many naturalists who are well competent to form a sound judgment is that man is descended from some less highly organised form The grounds upon which this conclusion rests will never be shaken for the close similarity between man and the lower animals in embryonic development as well as in innumerable points of structure and constitution both of high and of the most trifling importance —the rudiments which he retains and the abnormal reversion to which he is occasionally liable —are facts which cannot be disputed They have long been known but until recently they told us nothing with respect to the origin of man Now when viewed by the light of our knowledge of the whole organic world their meaning is unmistakable The great principle of evolution stands up clear and firm when these groups or facts are considered in connection with others such as the mutual affinities of the members of the same group their geographical distribution in past and present times and their geological succession It is incredible that all these facts should speak falsely He who is not content to look like a savage at the phenomena of nature as disconnected cannot any longer believe that man is the work of a separate act of creation He will be forced to admit that the close resemblance of the embryo of man to that for instance of a dog—the construction of his skull limbs and whole frame on the same plan with that of other mammals independently of the uses to which the parts may be put—the occasional reappearance of various structures, for instance of several muscles which man does not normally possess but which are common to the Quadrumana—and a crowd of analogous facts—all point in the plainest manner to the conclusion that man is the co descendant with other mammals of a common progenitor

We have seen that man incessantly presents individual differences in all parts of his body and in his mental faculties These differences or variations seem to be induced by the same general causes and to obey the same laws as with the lower animals In both cases similar laws of inheritance prevail Man tends to increase at a greater rate than his means of subsistence consequently he is occasionally subjected to a severe struggle for existence and natural selection will have effected whatever lies within its scope A succession of strongly marked variations of a similar nature is by no means requisite slight fluctuating differences in the individual suffice for the work of natural selection not that we have any reason to suppose that in the same species all parts of the organisation tend to vary to the same degree We may feel assured that the inherited effects of the long continued use or disuse of parts will have done much in the same direction with natural selection Modifications formerly of importance though no longer of any special use are long inherited When one part is modified other parts change through the principle of correlation of which we have instances in many curious cases of correlated monstrosities Something may be attributed to the ... of the surrounding con

siderable importance have been ga... sexual selection

No doubt man as well as every other animal presents structures which seem to our limited knowledge not to be now of any service to him nor to have been so formerly either for the general conditions of life or in the relations of one sex to the other Such structures

scope of public opinion, and receive praise and their opposites blame. But with the less civilised nations reason often errs, and many bad customs and base superstitions come within the same scope, and are then esteemed as high virtues, and their breach as heavy crimes.

The moral faculties are generally and justly esteemed as of higher value than the intellectual powers. But we should bear in mind that the activity of the mind in vividly recalling past impressions is one of the fundamental though secondary bases of conscience. This affords the strongest argument for educating and stimulating in all possible ways the intellectual faculties of every human being. No doubt a man with a torpid mind, if his social affections and sympathies are well developed, will be led to good actions, and may have a fairly sensitive conscience. But whatever renders the imagination more vivid and strengthens the habit of recalling and comparing past impressions, will make the conscience more sensitive and may even somewhat compensate for weak social affections and sympathies.

The moral nature of man has reached its present standard, partly through the advancement of his reasoning powers and consequently of a just public opinion, but especially from his sympathies having been rendered more tender and widely diffused through the effects of habit, example, instruction, and reflection. It is not improbable that after long practice virtuous tendencies may be inherited. With the more civilised races, the conviction of the existence of an all seeing Deity has had a po-

we escape ... in ...

actions, controlled by reason, afford him the safest rule. His conscience then becomes the supreme judge and monitor. Nevertheless the first foundation or origin of the moral sense lies in the social instincts, including sympathy; and these instincts no doubt were primarily gained, as in the case of the lower animals, through natural selection.

The belief in God has often been advanced as not only the greatest, but the most complete of all the distinctions between man and the lower animals. It is however impossible, as we have seen, to maintain that this belief is innate or instinctive in man. On the other hand a belief in all-pervading spiritual agencies seems to be universal; and apparently follows from

been ... —

His existence. But this is a rash argument, as we should thus be compelled to believe in the existence of many cruel and malignant spirits, only a little more powerful than man; for the belief in them is far more general than in a beneficent Deity. The idea of a universal and beneficent Creator does not seem to arise in the mind of man, until he has been elevated by

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ask, how does this bear on the belief in the immortality of the soul. The barbarous races of man, as Sir J. Lubbock has shown, possess no clear belief of this kind; but arguments derived from the primeval beliefs of savages are, as we have just seen, of little or no avail. Few persons feel any anxiety from the impossibility of determining at what precise period in the development of the individual, from the first trace of a minute germinal vesicle, man becomes an immortal being; and there is no greater cause for anxiety because the period cannot possibly be determined in the gradually ... seal

is bound to show why it is more ... explain the origin of man as a distinct species by descent from some lower form, through the laws of variation and natural selection, than to explain the birth of the individual through the laws of ordinary reproduction. The birth both of the species and of the individual are equally parts of that grand sequence of events, which our mind refuses to accept as the result of blind chance. The understanding revolts at such a conclusion, whether or not we are able to believe that every slight variation of structure,—the union of each pair in marriage,—the dissemination of each seed,—and other such events, have all been ordained for some special purpose.

Sexual selection has been treated at great

*The Rev. J. A. Picton gives a discussion to this effect in his New Theories and the Old Faith, 1870.

through natural selection The same conclusion may be extended to man the intellect must have been all important to him even at a very remote period as enabling him to invent and use language to make weapons tools traps &c whereby with the aid of his social habits he long ago became the most dominant of all living creatures

A great stride in the development of the intellect will have followed as soon as the half art and half instinct of language came into use for the continued use of language will have reacted on the brain and produced an inherited effect and this again will have reacted on the improvement of language As Mr Chauncey Wright[1] has well remarked the largeness of the brain in man relatively to his body compared with the lower animals may be attributed in chief part to the early use of some simple form of language —that wonderful engine which affixes signs to all sorts of objects and qualities and excites trains of thought which would never arise from the mere impression of the senses or if they did arise could not be followed out The higher intellectual powers of man such as those of ratiocination abstraction self-consciousness &c probably follow from the continued improvement and exercise of the other mental faculties

The development of the moral qualities is a more interesting problem The foundation lies in the social instincts including under this term the family ties These instincts are highly complex and in the case of tl s

a u the distinct emotion of sympathy Animals endowed with the social instincts take pleasure in one another s company warn one another of danger defend and aid one another in many ways These instincts do not extend to all the individuals of the species but only to those of the same community As they are highly beneficial to the species they have in all probability been acquired through natural selection

A moral being is one who is capable of reflecting on his past actions and their motives —of approving of some and disapproving of others and the fact that man is the one being who certainly deserves this designation is the greatest of all distinctions between him and the lower animals But in the fourth chapter I have endeavoured to shew that the moral sense follows firstly from the enduring and ever present nature of the social i

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ng to this condition of mind man cannot avoid looking both backwards and forwards and comparing past impressions Hence after some temporary desire or passion has mastered his social instincts he reflects and compares the now weakened impressions of such past impulses with the ever present social instincts and he then feels that sense of dissatisfaction which all unsatisfied instincts leave behind them he therefore resolves to act differently for the future —and this is conscience Any instinct permanently stronger or more enduring than another gives rise to a feeling which we express by saying that it ought to be obeyed A pointer dog if able to reflect on his past conduct would say to himself I ought (as indeed we say of him) to have pointed at that hare and not have yielded to the passing temptation of hunting it

Social animals are impelled partly by a wish to aid the members of their community in a general manner but more commonly to perform certain definite actions Man is impelled by the same general wish to aid his fellows but has few or no special instincts He differs also from the lower animals in the power of expressing his desires by words which thus become a guide to the aid required and bestowed The motive to give aid is likewise much modified in man it no longer consists solely of a blind instinctive impulse but is much influenced by the praise or blame of his fellows The appreciation and the bestowal of praise and blame both rest on sympathy and this emotion as we have seen is one of the most important elements of the social instincts Sympathy though gained as an instinct is also much strengthened by exercise or habit As all men desire their own happiness praise or blame is bestowed on actions and motives accord ng as

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a standard of right and wrong As the reasoning powers advance and experience is gained the remoter effects of certain lines of conduct on the character of the individual and on the general good are perceived and then the self regarding virtues come within the

[1] On the Limits of Natural Selection in the *North American Review* Oct. 1870 p 295

duction. In inn m rable instance these char acters are fully de l ped only t m tu tv and often d ri g ly part f th ear wh ch is alw s the breeding seaso Th mal s (passing er f w except nal ase) are the more acti e i co rtsh p tl y re th l tt r armed, and are rend red th more ttract e m an us ways. It is to be e pect lly bserved that the male d splay tl ir ttracti with th presence f th femal s

pre rence

sex.

B ari g mind th se facts, and tl marked results f man uncons select n wh n ppl ed t d m t cated animal and cult ted plants, t seems to me alm t ce ta n that if the ind iduals f n sex w re d ring l g series of g ti ns t p f pairing with certain ind d ls f th th se charact ised in som peculiar man th ff pring ould al wly b t urely becom modified n this sam m nn I ha n t tt mpted to conce l that, cept g wl th males are mo m rous than th f m l s, wh n polygamy pre ails, t d btf l h w th m re tt act males ceed in lea ng larg umbe of ff pri g t al nt tl pen nty in ornament tl harms than th less ttracti mal b t I h sh wn th t thus ld pr babl f llow from th f m les,— especiall th m re goro o s, wl l w uld be th first t breed,— pref rring n t nl ll more att acti b t t tl sam tim th m re g ro and t n mal

Alth l l som po t d ce

that th f males of man l rd nd som mam mals hould be l wed w tl fficient ta t t pprec t rnam ts, h h w ha reaso to ttrib t l se al select and thu is m re asto l g th ase f rept les, fish, and insects ll t w really kn w little about th m nd f th low an m ls. It an t be pposed f nstance that mal b rds of parad se peacocks l kl tak ch pains rect g, pread g and brating th ir be tiful plum bef re th f males fo

purpose We b uld remember the fact gi en n cell t authority n a form r chapter that se e al peahens, when debarred fr n an admired n al remained wid ws du ing a whole season r tl r than pair w th an the b rd

Ne ertl less I kn w of n fact n nat ral hist ry more w derful than th t tl e f mal A gu pheasant sh uld ppreciate tl e ex quis te sl ad ng of th ball and sock t rn m nts and tl l gant patt rns on th w ng f ath rs f tl e m l He who tl nks that tl e mal was re ted as h now xists mu t admit that th gre t pl m s, wh ch pre ent the wi g from be g used f ll ght, and wl ch are displ yed d ring court h p d at i o othe tum t pecul a to th e peci so h cre t prec con ct n that th mal Argus ph asant ac red l beauty grad ally thro gh th pref

been ad anced thro gh x rcise or hab t, ju t as wn tast gradually impro ed In th m le thro gl th f rtu ate cl ance of a f w feath rs be ng l ft unchanged we can d s tin tl trace h w simpl pot w th l ttl f l ous had ng n n d may ha been d l ped b mall t p int the w derful b ll d sock t rnam nts a d t s probabl t

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could ia th b ty f tl mal s, and which g n ally coinc d w th wn tandard h uld ffect th t th rv -cells f th brai in the h ghest w ll as in th l west m mbers f the rt

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Th read wh l as tak n th tro bl to g through th se al ch pt rs de ted t se u selecti n, will b abl to j dg h w far th co cl n t which I ha arri ed are ppo ted by uffici t d ce If he accepts these con clusions h ma I think, safely extend th m to mankind b t t w uld be s pe flu us he

much remains doubtful but I have endeavoured to give a fair view of the whole case In the lower divisions of the animal kingdom sexual selection seems to have done nothing such animals are often affixed for life to the same spot or have the sexes combined in the same individual or what is still more important their perceptive and intellectual faculties are not sufficiently advanced to allow of the feelings of love and jealousy or of the exertion of choice When however we come to the Arthropoda and Vertebrata even to the lowest classes in these two great sub kingdoms sexual selection has effected much

In the several great classes of the animal kingdom —in mammals birds reptiles fishes insects and even crustaceans —the differences between the sexes follow nearl th

nghting with their rivals They are generally stronger and
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exclusively or in a much higher degree than the females with organs for vocal or instrumental music and with odoriferous glands They are ornamental with infinitely diversified appendages and with the most brilliant or conspicuous colour often arranged in elegant patterns whil t the females are unadorned When the sexes differ in more important structures

only part of the year namely the breeding season They have in many cases been more or less transferred to the females and in the latter case they often appear in her as mere rudiments They are lost or never gained by the males after emasculation Generally they are not developed in the male during early youth but appear a short time before the age for reproduction Hence in most cases the young of both sexes resemble each other and the female somewhat resembles her young offspring throughout life In almo t every great class a few anomalous cases occur where there has been an almost complete transpo ition of the characters proper to the two sexes the females assuming characters which properly belong to the males This surprising uniformity in the laws regulating the differences between the sexes in so many and such widely separated cla ses is intelligible if we admit the action of one common cause namely sexual selection

Sexual selection depends on the succes

of the same sex generally the males in order to drive away or kill their rivals the female remaining passive whilst in the other the struggle is likewise between the individuals of the same sex in order to excite or charm those of the opposite sex generally the females, which no longer remain passive but select the more agreeable partners This latter kind of selection is closely analogous to that which man unintentionally yet effectually brings to

modify the breed

The laws of inheritance determine whether characters gained through sexual selection by either sex shall be transmitted to the same sex or to both as well as the age at which they shall be developed It appears that variations arising late in life are commonly transmitted to one and the same sex Variability is the necessary basis for the action of selection and is wholly independent of it It follows from this that variations of the same general nature have often been taken advantage of and accumulated through sexual selection in relation to the propagation of the pecies as well as through natural s lection in relation to the general purpo es of life Hence secondary sexual

The modifications acquired through sexual selection are often so strongly pronounced that the two exes have frequently been rank d as di tinct pecies or even as distinct genera Such strongly marked differences must be in some manner highly important and we know that they have been acquired in some instances at the cost not only of inconvenience but of expo ure to actual danger

The belief in the power of exual selection rests chiefly on the following considerations. Certain characters are confined to one sex and this alone renders it probable that in mo t cases they are connected with the act of repro-

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may gi e him hope f r till high r d ti y in th d stant fut re B t we are not h re concerned with h pes or fea s, only with tl e tr th as far as ur reason pe mits us to disco er i

d I h e gi en the e id nce to th best f my ab lity We m st h wev r acknowledge as i seems to me that man with all his noble qual t e w th ymp tl y wh ch feels f the m t d based with bene olence which e tends not nly to otl r men but to the humbl t l i g cre ture with hi god like int llect wh h l as pen trated nto the moveme ts and constituti n f the solar system—with all tl se xalted pow rs—Man still bears in his bod ly f ame the nd l ble stamp of his lowly origin

to repeat what I have so lately said on the manner in which sexual selection apparently has acted on man both on the male and female side causing the two sexes to differ in body and mind and the several races to differ from each other in various characters as well as from their ancient and lowly organised progenitors

He who admits the principle of sexual selection will be led to the remarkable conclusion that the nervous system n

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various bodily structures and of certain mental qualities Courage pugnacity perseverance strength and size of body weapons of all kinds musical organs both vocal and instrumental bright colours and ornamental appendages have all been indirectly gained by the one sex or the other through the exertion of choice the influence of love and jealousy and the appreciation of the beautiful in sound colour or form and these powers of the mind manifestly depend on the development of the brain

Man scans with scrupulous care the character and pedigree of his horses cattle and dogs before he matches them but when he comes to his own marriage he rarely or never takes any such care He is impelled by nearly the same motives as the lower animals when they are left to their own free choice though he is in so far superior to them that he highly values mental charms and virtues On the other hand he is strongly attracted by mere wealth or rank Yet he might by selection do something not only for the bodily constitution and frame of his offspring but for their intellectual and moral qualities Both sexes ought to refrain from marriage if they are in

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known Everyone does good service who aids towards this end When the principles of breeding and inheritance are better understood we shall not hear ignorant members of our legislature rejecting with scorn a plan for ascertaining whether or not consanguineous marriages are injurious to man

The advancement of the welfare of mankind is a most intricate problem all ought to refrain from marriage who cannot avoid abject poverty for their children for poverty is not only a great evil but tends to its own increase by leading to recklessness in marriage On the other hand as Mr Galton has remarked if the prudent avoid marriage whilst the reckless marry the inf

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able should not be prevented by laws or customs from succeeding best and rearing the largest number of offspring Important as the struggle for existence has been and even still is yet as far as the highest part of man's nature is concerned there are other agencies more important For the moral qualities are advanced either directly or indirectly much more through the effects of habit the reasoning powers instruction

which afforded the basis for the development of the moral sense

The main conclusion arrived at in this work namely that man is descended from some lowly organised form will I regret to think be highly distasteful to many But there can hardly be a doubt that we are descended from barbarians The astonishment which I felt on first seeing a party of Fuegians on a wild and broken shore will never be forgotten by me for the reflection at once rushed into my mind —such were our ancestors These men were absolutely naked and bedaubed with paint, their long hair was tangled their mouths frothed with excitement and their expression was wild startled and distrustful They possessed hardly any art and like wild animals lived on what they could catch they had no government and were merciless to every one not of their own small tribe He who has seen a savage in his native land will not feel much shame if forced to acknowledge that the blood of some more humble c

pains to make their d splay fully and if mad before two observ rs, they turn t him wh seems to pay the most attenti n.

With respect to th origin of th hab t, von Fische remarks th t his m nk ys like to ha their naked hind r end patted stroked and that they th grunt w th pl as re Th y ft n also turn this part of th r bodies to oth r monkeys to ha b ts l dirt p ked ff nd so no doubt t w uld be with respect to th rns. But the hab t with ad lt animals is connected t certain exte t with sexual feelings, f von Fischer wat hed thro gh glass door a f male *Cynopithecus* ger and sh d ring se eral days, *mdr hte nd dem M chen mit purpurrothen Tonen d st l g othet Sit flach ecke, was ich f uher n d e.em Th er bemerkt hatte Beim t bl k d es C gen standes riegte sich das M nchen hil h dena poliert heft g den St ben benfalls gurgelnde Laute usstossend* As all tl m n k ys which l e th hind r part f th ir

h. —

I should ha th ght that th re was no need for the se es t recognise ach otl t a distance. It seems t m more probabl th t th bright colo rs, wh th on th face hind end, as in th mandrill both serv as a

al h, ..

should ha bee thus part of th bod es hich has bee m re less deco ted Th fact that t is nly th monk thus charact sed hich, as far as t prese t kn wn, act in this mann as greet g t wards th m he rend rs t d btf l wl th th hab t was first acquired from som ind pend t cause, and that aft rward th parts in q esti w re coloured as se al rnam t wh th th colouring and th hal t of t rning round w re first acquired thro gh ari t n and sexual selection, and that aft rw rd th hab t was re tained as gn f pl as re as a greeting, thro gh th principl of inh rited associ tion. This princ ple ppare tl comes t pla many occasi ns thus t is generally admitted that th so gs of b rd serv mainl as an t tractio d ri g th seaso f l and that th lek or great co gregations of th black grouse are connected w th th ir courtship b t th e h b t f nging has been retained b some birds wl n th r feel happy for nstance by the comm n rob n, and the hab t of congreg t g has been retained by th black grouse during oth r seasons of the year

I beg l ave to refe to one othe po t in re latio to sexual select on. It has been ob ected that this f rm of select n, as far as the orna m nt f th males are concerned impl s that all f mal s w thin th sam district m t possess and ercise actly the sam taste It should h w r be observed in the first place that altl h the ran of ariat n of a speci may be ry larg t is by no m ans and finite I h e elsewh re gi n a good in tance of tl fact n the p geon of wh ch th re are t l ast a hundred ari ti s differing wid ly in th r colours, and t least a score f ari ties of th f wl diff ring in the sam kind f w y b t th rang f col n these two peci s s xtrem ly di ti t. Th refore th f males f natural peci cann t h e an unlimited scope fo th taste In th second place I presume t[illegible] nn onl f sexual

mure n which h be uty d penas. n ma m drill has n t nly th hind end of h

th indi dual m an th w y Th m les wh h w re th handsomest th mo t t tracti m any mann t th f males w ld pair oft nest, and w uld lea th m re off spring than oth males. Th ff pring f th f rm alth gh ari usly int rcrossed w uld th nherit th peculiariti of th ir f th rs tran mit an creased t d ncy to vary in th sam man Conseq ntly th wh l body f mal inhab ting th sam country w ld t d from the ffects of constant int rossing t becom modified almo t unif rmly b t som times littl m re in ne characte and som times in an th th gh at an trem ly slow rate all ultimately being thus

SUPPLEMENTAL NOTE

ON SEXUAL SELECTION IN RELATION TO MONKEYS

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In the discussion on Sexual Selection in my *Descent of Man* no case interested and perplexed me so much as the brightly-coloured hinder ends and adjoining parts of certain monkeys. As these parts are more brightly coloured in one sex than the other and as they become more brilliant during the season of love I concluded that the colours had been gained as a sexual attraction. I was well aware that I thus laid myself open to ridicule though in fact it is not more surprising that a monkey should display his bright red hinder end than that a peacock should display his magnificent tail. I had however at that time no evidence of monkeys exhibiting this part of their bodies during their courtship and such display in the case of birds affords the best evidence that the ornaments of the males are of service to them by attracting or exciting the females. I have lately read an article by Joh von Fischer of Gotha published in *Der Zoologische Garten* April 1876 on the expression of monkeys under various emotions which is well worthy of study by any one interested in the subject and which shews that the author is a careful and acute observer. In this article there is an account of the behaviour of a young male mandrill when he first beheld himself in a looking glass and it is added that after a time he turned round and presented his red hinder end to the glass. Accordingly I wrote to Herr J von Fischer to ask what he supposed was the meaning of this strange action and he has sent me two long letters full of new and curious details which will I hope be hereafter published. He says that he was himself at first perplexed by the above action and was thus led carefully to observe several individuals of various other species of monkeys which he has long kept in his house. He finds that not only the mandrill (*Cynocephalus mormon*) but the drill (*C leucophæus*) and three other kinds of baboons (*C hamadryas sphinx* and *babouin*) also *Cynopithecus niger* and *Macacus rhesus* and *nemestrinus* turn this part of their bodies, which in all these species is more or less brightly coloured to him when they are pleased and to other persons as a sort of greeting. He took pains to cure a *Macacus rhesus* which he had kept for five years of this indecorous habit and at last succeeded. These monkeys are particularly apt to act in this manner grinning at the same time when first introduced to a new monkey but often also to their old monkey friends and after this mutual display they begin to play together. The young mandrill ceased spontaneously after a time to act in this manner towards his master von Fischer but continued to do so towards persons who were strangers and to new monkeys. A young *Cynopithecus niger* never acted excepting on one occasion in this way towards his master but frequently towards strangers, and continues to do so up to the present time. From these facts von Fischer concludes that the monkeys which behaved in this manner before a looking glass (viz the mandrill drill *Cynopithecus niger Macacus rhesus* and *nemestrinus*) acted as if their reflection were a new acquaintance. The mandrill and drill which have their hinder ends especially ornamented display it even whilst quite young more frequently and more ostentatiously than do the other kinds. Next in order comes *Cynocephalus hamadryas* whilst the other species act in this manner seldomer. The individuals however of the same species vary in this respect and some which were very shy never displayed their hinder ends. It deserves especial attention that von Fischer has never seen any species purposely exhibit the hinder part of its body if not at all coloured. This remark applies to many individuals of *Macacus cynomolgus* and *Cercocebus radiatus* (which is closely allied to *M rhesus*) to three species of Cercopithecus and several American monkeys. The habit of turning the hinder ends as a greeting to an old friend or new acquaintance which seems to us so odd is not really more so than the habits of many savages, for instance that of rubbing their bellies with their hands or rubbing noses together. The habit with the mandrill and drill seems to be instinctive or inherited as it was followed by very young animals but it is modified or guided like so many other instincts, by observation for von Fischer says that they take

rendered more attractive to the females The process is like that which I have called unconscious selection by man and of which I have given several instances In one country the inhabitants value a fleet or light dog or horse and in another country a l

[illegible]

[illegible] to have been modified in the desired manner almost uniformly though differently in each country In two absolutely distinct countries inhabited by the same species the individuals of which can never during long ages have intermigrated and intercrossed and where moreover the variations will probably not have been identically the same sexual selection might cause the mal [illegible]

[illegible] different tastes with respect to form sound or colour However this may be I have given in my *Descent of Man* instances of closely allied birds inhabiting d [illegible] the dis- [illegible] much probability to the action of sexual selection

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